Mission Restoration Project

Forest Vegetation Report

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for:
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Okanogan-Wenatchee National Forest

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Regulatory Framework

Land and Resource Management Plan

The OkanoganNational Forest Land and Resource Management Plan (LRMP; USDA 1989) provides standards and guidelines for forest vegetation management in this project area. The management areas within the project boundary are described below along with the Standards and Guidelines that affect forest vegetation management. Approximately 4% of the project area is not on National Forest System (NFS) lands and therefore has no LRMP management designation.

Forest-wide Standards and Guidelines

- **5-1:** No scheduled or non-scheduled timber harvest or firewood collection shall be permitted in mixed conifer old growth stands.
- **20-14:**Commercial thinnings shall be from below
- **20-15**: Intermediate (thinning) harvests should not intensify existing insect or disease problems, and should reduce the impact of damaging agents in the future stand.
- **20-28:** To the extent practicable, management should foster stands with mixed species composition
- **20-34**: Precommercial thinning from below shall be the preferred method of stocking control. Prescribed fire may be used where it is the most cost effective for achieving the growth and resource goals of the management area.
- **20-35**: All precommercial thinning and stand improvement activities should be designed to minimize the spread of disease, or the conditions favorable for injurious forest insects.

- **20-41:**Forest openings created by the application of even-age harvest cutting methods shall be limited to a maximum of 40 acres.
- **20-44:** A harvested area of commercial forest land shall no longer be considered a created opening for silvicultural purposes when stocking surveys indicate prescribed tree stocking that is at least 4 ½ feet high, or as otherwise determined by goals of Management Areas, and free to grow.

Management Areas

Management Area 5 (11% of the project area): the LRMP Goal is to provide opportunities for recreation and viewing scenery in a roaded natural setting with a visual quality objective of retention or partial retention. Standards and Guidelines for forest vegetation management are as follows:

- MA5-19F: Stands shall be managed to control insect and disease problems and to control outbreaks, to the extent practicable.
- MA5-20A: Timber activities shall be designed to maintain or enhance roaded natural recreation opportunities and to provide a vegetation condition that meets the visual quality objective in perpetuity.
- MA5-20H: A created opening for visual quality management purposes is defined as an area where dominant trees are less than 20 feet tall.

Management Area 14 (22% of the project area): the LRMP goal is to provide a diversity of wildlife habitat, including deer winter range, while growing and producing merchantable wood fiber. Standards and Guidelines for Fire and Fuels are:

- MA14-20A: Scheduled and non-scheduled timber harvests shall be designed to perpetuate wildlife habitat and to address current habitat needs.

Management Area 25 (30% of the project area): the LRMP goal is to intensively manage the timber and range resources using both even-aged and uneven-aged silvicultural practices. Manage to achieve a high present net value and a high level of timber and range outputs while protecting the basic productivity of the land and providing for the production of wildlife, recreation opportunities, and other resources. Standards and Guidelines for forest vegetation are as follows:

- MA25-19F: Stands with high level of dwarf mistletoe or root rot shall receive the highest priority for silvicultural treatment.

Northwest Forest Plan Management Areas

The LRMP was amended by the Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl (hereafter referred to as the Northwest Forest Plan, or NWFP; USDA and USDI 1994). The NWFP created additional management designations that overlie the LRMP management areas described above. There is considerable overlap between some NWFP designations, therefore the total percentage of lands within NWFP designations will exceed 100%. The standards and guidelines from Okanogan LRMP apply where they are more restrictive or provide greater benefits to late successional forest-related species than

other provisions of these standards and guidelines. The NWFP management areas and standards and guidelines related to forestvegetation management in the project area are listed below.

Congressionally Reserved: This designation covers 31% of the project area and lies completely within LRMP MA15B, the Lake Chelan-Sawtooth Wilderness. The NWFP does not describe any specific standards or guidelines for forest vegetation management in Congressional Reserved areas.

Riparian Reserves: Riparian Reserves (RRs) include 10% of the project area and overlap portions of all other land management designations in this project area. RRs encompass areasadjacent to all streams with intermittent or perennial water flow, wetlands, ponds, lakes, and adjacent unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis. RR vegetation management treatment buffers are described in the Aquatics and Hydrology resource report. RR Standards and Guidelines for forest vegetation management (Timber Management)) are as follows:

- TM-1. Prohibit timber harvest, including fuelwood cutting, in Riparian Reserves, except as described below.
    a. Apply silvicultural practices for Riparian Reserves to control stocking, reestablish and manage stands, and acquire desired vegetation characteristics needed to attain Aquatic Conservation Strategy objectives.

Late Successional Reserves (LSRs): Two LSRs cover 5% of the project area and lie within LRMP MA 5 (106 acres of the Twisp River LSR) and MA25 (2338 acres of the Sawtooth LSR). NFWP objectives for LSRs include managing these areas to protect and enhance conditions of late-successional and old-growth forest ecosystems, which serve as habitat for late-successional and old-growth related species including the northern spotted owl. LSR Standards and Guidelines for forest vegetation management (Silviculture) state that stand and vegetation management of any kind, including prescribed burning, is considered a silvicultural treatment. East of the Cascade Mountains silvicultural treatment is allowed to reduce the risk of large-scale disturbances that can eliminate spotted owl habitat. Silvicultural activities aimed at reducing risk shall focus on younger stands in LSRs with the objective of accelerating the development of late successional conditions while making the future stand less susceptible to natural disturbances.

Matrix: This designation covers 60% of the project area and lies within LRMP MA 5 (5250 acres), MA14 (10,979 acres), MA17 (38 acres), MA25 (12,486 acres) and MA 26 (1163 acres).NWFP objectives for Matrix allow for timber harvest and other silvicultural activities in suitable forest lands.NWFP Standards and Guidelines related to timber harvest emphasize green tree and snag retention in matrix management. Matrix retention requirements for harvest units which are not intermediate (thinning) treatments in young stands, specify that at least 15 percent of the area associated with each cutting unit will be retained. As a general guide, 70 percent of the total area retained should be aggregates of 0.5 to 2.5 or more acres in size with the remainder as dispersed structures (individual trees and smaller clumps less 0.5 acre). To the extent possible, patches and dispersed retention should include the largest, oldest live trees, decadent or leaning trees, and hard snags occurring in the unit. Patches should be retained indefinitely.

Special Area Designations

Sawtooth Inventoried Roadless Area

The project area contains approximately 3300 acres of the Sawtooth Inventoried Roadless Area (IRA). Scheduled timber harvest shall not occur in this IRA.

Watershed Analysis

Twisp River Watershed Analysis (USDA 1995a):

This analysis, which covers the Buttermilk Creek portion of the Mission project area, determined that past management activities and successional progress have favored an increase of late-seral (shade tolerant) tree species and multiple canopy level stands with high risk associated with insects, disease, and eventually fire. The assessment determined that it would be beneficial to increase the number of stands dominated by early seral (tree) species and/or stand structures which are resistant to insects and diseases that affect late-seral forest stands where Douglas-fir has replaced ponderosa pine as the dominant tree species. Vegetation management recommendations relevant to this analysis include:

- **Restore/maintain stands dominated by large, mature ponderosa pine trees.**

  Manage vegetation to favor ponderosa pine tree component recovery. Outside of Wilderness, this would include harvest to reduce site competition for ponderosa pine, stand manipulation to emphasize growth in ponderosa pine component, and site preparation to achieve ponderosa pine regeneration.

- **Manage vegetation to reduce stand susceptibility to disturbance caused by insects or disease in the matrix land allocation.**

  Change stand structure and species composition with stand manipulation projects to enhance stand vigor and resiliency. This would include timber harvest or timber stand improvement treatments to encourage stand thrift.

Libby Creek (USDA 1995b) and Lower Methow Watershed Analysis (USDA 1999):

These analyses cover the Libby Creek portion of the Mission project area andthey determined that management activities have influenced watershed vegetation pattern and structure to the point where species composition and some stand structural stages currently are out of balance with the historical range of variation.Vegetation management recommendations in ponderosa pine/Douglas-fir and Douglas-fir forest vegetation types relevant to this analysis include:

Mature Stands with multiple canopy levels

- Restore stand canopy structures and species composition to historic levels by reducing excess understory stocking. Maintain mature, large diameter trees in overstocked stands by reducing excess understory stocking with timber harvest, thinning sub-merchantable trees, and prescribed burning.
- Reduce dwarf mistletoe infection in the understory (particularly in Douglas-fir) and confine infection primarily to large, mature trees which historically remained following periodic underburning.
- Regenerate stands with severe dwarf mistletoe infestations to ponderosa pine and other early seral tree species.

Young Stands of Poles and Small Sawtimber

- Maintain remnant large diameter trees to enhance canopy structural diversity and move stands toward attainment of mature size more rapidly.
- Reduce competition in overstocked stands to provide growing space that would allow (residual) trees to reach larger size faster.
- Manage density of overstocked stands with timber harvest, thinning of sub-merchantable trees, and prescribed burning.
- Promote ponderosa pine and other early seral (tree) species by removing excess Douglas-fir stocking.
- Reduce dwarf mistletoe infection levels (especially on warm/dry sites) by removing heavily infected trees.
- Regenerate severely infected stands to ponderosa pine and other early seral tree species.

Other Guidance or Recommendations

Okanogan-Wenatchee Forest Restoration Strategy

The Okanogan-Wenatchee Forest Restoration Strategy (Restoration Strategy; USDA 2012) provides a planning framework, based on principles of landscape-level restoration ecology, to restore the sustainability and resiliency of forested ecosystems on the Okanogan-Wenatchee National Forest. It was developed to provide land managers with the ability to efficiently examine broad Forest landscapes, allowing managers to select high priority areas, design integrated restoration treatments, and consider historical and potential future reference conditions under different climate scenarios. One key premise of the Restoration Strategy is that maintaining and restoring forest vegetation conditions (structure, composition, and vulnerability to insects) to levels that are within the historical and future range of variability (where HRV and FRV overlap) will provide for more sustainable and resilient forest ecosystems. Forest direction mandates use of the peer-reviewed Restoration Strategy to analyze conditions in the Mission project area (Landscape Evaluation) and develop possible restoration treatment options in response to landscape evaluation findings.

Spruce Budworm Assessment

The Methow Valley Ranger District Western Spruce Budworm Landscape Assessment (USDA 2012a) was prepared to assess current and potential near-term (3 – 10 years) implications of western spruce budworm (WSB) (*Choristoneura occidentalis*) outbreak on vegetation, fire and fuels, wildlife, and aquatics resources. The assessment identified potential management opportunities for consideration in project-scale planning which includes the followingrecommendations applicable to forest vegetation management in this project:

- Focus silvicultural and prescribed fire treatments in the dry-cover types to reduce susceptibility to western spruce budworm and reduce risk of uncharacteristic crown fires. Given the scope of the problem, implement the Forest Restoration Strategy at the 5th field watershed level.
- Implement vegetation management treatments to maintain and restore dry forest conditions that reflect historical tree densities, species composition, canopy structures, and size classes, including large and old trees.

National Roadmap for Responding to Climate Change

This document provides guidance for National Forests to adapt and prepare for changing climates, with a management emphasis on restoring the functions and processes characteristic of healthy, resilient ecosystems through adaptive restoration. The Roadmap identifies the connection between restoration and developing the ability of ecosystems to withstand the stresses and uncertainties associated with climate change (USDA 2011).

Affected Environmentand Environmental Consequences

Resource Indicators and Measures

Figure 1 describes the forest vegetation resource indicators that will be used to evaluate existing conditions in this project area and effects of proposed treatments.

Figure 1. Resource Indicators and Measures for Assessing Effects

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
Forest Vegetation Composition and Structure.	The amount and arrangement of dry and moist forest structures compared to the desired range of variability.	Percentage of Buttermilk and LibbyCreek landscapes occupied by dry forest and moist forest structures.	P&N #3	Restoration Strategy
		Average patch size (in acres) of dry forest and moist forest structures in the Buttermilk and Libby Creek landscapes.		
	Forest patches with large and medium size trees.	Acres treated in the Buttermilk and Libby Creek landscapes to maintain and restore large trees in patches with medium, large, or large and medium size trees.		

Resource Element	Resource Indicator	Measure	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
Resilience to biotic natural disturbances.	Western spruce budworm vulnerability compared to the desired range of variability.	Percentage of Buttermilk and Libby Creek landscapes with high, moderate, and low risk of Western spruce budworm infestation.	P&N #3	LRMP S&G 20-15, 20-35, MA5-19F Restoration Strategy Spruce Budworm Assessment
	Forest vegetation vulnerable Douglas-fir bark beetles.	Acres of treatment in the Buttermilk and Libby landscapes with high or moderate risk of Douglas-fir bark beetles.	P&N #3	LRMP S&G 20-15, 20-35, MA5-19F
	Forest vegetation vulnerable to dwarf mistletoe infection.	Acres treated in the Buttermilk and Libby Creek landscapes to reduce vulnerability to dwarf mistletoe infection.	P&N #3	LRMP S&G 20-15, 20-35, MA25-19F, MA5-19F

Methodology

The methodologies used to analyze resource indicators are described below.

Resource indicator: The amount and arrangement of dry and moist forest vegetation structures compared to the desired range of variability.

The Restoration Strategy (USDA 2012) outlines the analysis process used to evaluate landscape conditions and assess whether landscape characteristics including forest vegetation composition and structures have departed from historic and/or future ranges of variability. The process involves photo interpretation conducted by Forest Service personnel with local knowledge of the project area to identify multiple vegetation and landscape attributes in each of the two sub-watersheds in the project area: Buttermilk Creek and Libby Creek. Photo interpreted data was field verified for accuracy in portions of both sub-watersheds prior to data analysis. The Ecosystem Management Decision Support (EMDS) modeling tool (EMDS 3.0.2;Reynolds and Hessburg 2005) used these data to evaluate existing landscape and patch-level characteristics and trends separately for each sub-watershed. EMDS was used to compare the current conditions to a range of historical and future reference conditions for each sub-watershed to give insights into how dry and moist forest vegetation composition and structure have changed and how they are likely to change in the future with a predicted warmer and drier climate.

In this analysis, forest structure classes defined as old forest multistory (OFMS), old forest single story (OFSS), stem exclusion closed canopy (SECC), stem exclusion open canopy (SEOC), stand initiation (SI), understory reinitiation (UR), and young forest multistory (YFMS) (O'Hara et al. 1996; Hessburg et al.

2000) are the primary characteristics used to assess how dry and moist forest vegetation composition and structure has changed from 80th percentile values for the historical range of variability (HRV) and future range of variability (FRV). The HRV and FRV for this project, were developed from photo interpreted and modelled data collected from mid-1950s aerial photos. Dry forest is defined as hot, warm, or cool dry sites where ponderosa pine or Douglas-fir is the dominant climatic climax tree species. Moist forest is defined as cool mesic sites where Douglas-fir or subalpine fir are the dominant climatic climax tree species. Structure classes describe how forest vegetation develops over time from the stand initiation stage to intermediate successional stages (including stem exclusion closed canopy, stem exclusion open canopy, understory reinitiation, and young forest multistory) and eventually to later successional stages including old forest multistory and old forest single story. The amount and arrangement (collectively referred to as pattern) of structure classes is considered to be an important indicator of landscape condition (Reynolds and Hessburg 2005) in the landscape evaluation and restoration process.

EMDS was used to classify dry and moist forest structures in each sub-watershed into OFMS, OFSS, SECC, SEOC, SI, UR or YFMS classes. Each structure class in the dry and moist forest types was measured by the percentage of the landscape to indicate the overall amount on the landscape and by average patch size to indicate the arrangement of structure classes on the landscape.Current conditions in each sub-watershed were evaluated independently with HRV and FRV reference conditions based on the ecological subregion (ESR) to which they are assigned. ESRs are comprised of areas (sub-watersheds) with similar climate, geology, topography, aquatic characteristics, and disturbance history (Hessburg et al. 2000). The FRV (Gärtner et al. 2008) was developed to provide insight as to how forest vegetation in the sub-watersheds may be affected by a changing climate. FRV reference conditions for a given sub-watershed are based on HRV reference conditions of the next (not necessarily geographically located) environmentally warmer and drier ESR. This is a conservative approach for estimating climate change, and it may underestimate the FRV if the degree of climate change is more severe than indicated by the next warmer and drier ESR.

The desired values for the amount and arrangement of dry and moist forest structure classes in this analysis were determined by finding where the HRV and FRV overlap; this intersection is called “the desired range of variability” (DRV)for this analysis. One key premise of the Restoration Strategy, which is based on current knowledge of existing and anticipated future environmental conditions, is that maintaining and restoring forest vegetation conditions to levels that are within ranges where the HRV and FRV overlap will provide for more sustainable and resilient forest ecosystems.Landscape prescriptions for dry and moist forest structure in the Buttermilk Creek and Libby Creek sub-watersheds were developed based on the need to maintain the amount and arrangement of structure classes within this intersecting range, or to move the amount and arrangement of structure classes closer toward the intersecting range where they are outside of (departed from) these values. Detailed descriptions of sub-watershed landscape prescriptions and processes used to develop them are provided in Churchill 2016 and Churchill 2015. Potential vegetation treatments, including timber harvest and non-commercial thinning treatments, were identified to maintain or change the amount and arrangement of dry and moist forest structure classes based on departures from desired ranges of variability. Treatment

locations to apply the landscape prescriptions were developed in ArcGIS based on field reconnaissance, operational feasibility, discussion with resource specialists, and public input.

Where 50% or more of an EMDS vegetation polygon would be affected by treatment, structure classes were reclassified based on estimated effects of the sum of proposed vegetation and fuels management treatments applied within the polygon. The resulting post-treatment data sets for each sub-watershed were modeled by EMDS and evaluated to determine whether the proposed treatments and locations would degrade, maintain, or improve the amount and arrangement of dry and moist forest structure classes when compared to the desired range of variability.Sensitivity analysis of using a 50% or greater treatment threshold for reclassifying vegetation polygon post-treatment structure classes indicates thatthis method may have overestimated treatment effects(size of the treatment foot print) compared to the actual number of acres treated by approximately five percent in the Libby Creek sub-watershed. This difference is equivalent to approximately one percent of the total Libby Creek sub-watershed area. Sensitivity analysis indicates that the method used may have underestimated treatment effects by approximately one half of one percent compared to the actual number of acres treated in the Buttermilk Creek sub-watershed. These discrepancies were ignored in this analysis.

A small portion of the project area (205 acres) lies outside of the Buttermilk and Libby Creek sub-watersheds, but within the greater Twisp River watershed. This area was added to the project at the request of adjacent residents in the Buttermilk Firewise Community, and is referred to in this analysis as the Buttermilk Annex. The purpose of treatments in this area is based on the need to reduce fire hazard to the WUI, not maintenance and restoration of forest vegetation composition and structure.This portion of the project area was not analyzed with EMDS because it comprises such a small portion of the Twisp River watershed (less than one percent) and proposed forest vegetation treatment effects would be immeasurable in the context of landscape level restoration objectives.

Resource Indicator: Forest patches with large and medium size trees.

EMDS modeling of photo interpreted data was used to characterize the presence of large and medium size trees in vegetation polygons (patches) in the entire Buttermilk Creek and Libby Creek sub-watersheds in the following manner:

- **Medium** = overstory trees 16 inches to 25 inches diameter at breast height (dbh).
- **Large** = overstory trees larger than 25 inches dbh with understory trees smaller than 16 inches dbh.
- **Large and medium** = large size overstory trees (> 25 inches dbh) with medium size understory trees 16 inches to 25 inches dbh.

Estimated effects of implementing the proposed vegetation management treatments indicated that there would be no measurable difference from existing and post-treatment conditions regarding the percentage of the landscape and average patch size of forest patches with medium, large, orlarge and medium size trees in the Buttermilk Creek and Libby Creek sub-watersheds. The total acreage of

treatment to maintain and restore large trees in EMDS vegetation polygons (patches) with medium, large, and large and medium size trees was used to measure the effects of alternatives in each sub-watershed.

Resource Indicator: Western spruce budworm vulnerability compared to the desired range of variability.

The Restoration Strategy (USDA 2012) outlines the analysis process used to evaluate landscape conditions and assess whether landscape characteristics including vulnerability to insect infestation have departed from historic and/or future ranges of variability. EMDS modeling of photo interpreted data was used to characterize the vulnerability of vegetation polygons to infestation by the western spruce budworm in each sub-watershed. Western spruce budworm vulnerability was classified into three categories (high, moderate, or low) based on site quality, host abundance, canopy structure, stand density, host age, patch vigor, and host patch connectivity of vegetation polygons (Hessburg et al. 1999a, USDA 2012). This rating is used to evaluate how vulnerable a landscape is to the propagation of western spruce budworm and shows how insect habitat has changed over time in its amount and configuration. Each vulnerability class was measured by the percentage of the landscape to indicate the overall amount on the landscape. Average patch size and patch density were not included in this analysis because there was little or no detectable difference between current and estimated post treatment conditions for these metrics in all vulnerability classes in both sub-watersheds, thus providing no meaningful differences to compare the alternatives analyzed. Current conditions in each sub-watershed were evaluated independently and compared with HRV and FRV reference conditions based on the ecological subregion (ESR) to which they are assigned.

The desired values for the amount and arrangement of western spruce budworm vulnerability classes in this analysis were determined by finding where the HRV and FRV overlap; this intersection is called “the desired range of variability” for this analysis. Where 50% or more of an EMDS vegetation polygon would be affected by treatment, vulnerability classes were reclassified based on estimated effects of the sum of proposed vegetation and fuels management treatments applied within the polygon. The resulting post-treatment datasetsfor each sub-watershed were modeled by EMDS and evaluated to determine whether the proposed treatments and locations would degrade, maintain, or improve the overall amount and configuration (average patch size and patch density)of vulnerability classes when compared to the desired range of variability. Sensitivity analysis of using a 50% or greater treatment threshold for reclassifying vegetation polygon post-treatment vulnerability classes indicates that this method may have overestimated treatment effects (size of the treatment foot print) compared to the actual number of acres treated by approximately five percent in the Libby Creek sub-watershed. This difference is equivalent to approximately one percent of the total Libby Creek sub-watershed area. The same method used may have underestimated treatment effects by approximately one half of one percent compared to the actual number of acres treated in the Buttermilk Creek sub-watershed. These discrepancies were ignored in this analysis.

Resource Indicator: Forest vegetation vulnerable Douglas-fir bark beetles.

The Restoration Strategy (USDA 2012) outlines the analysis process used to evaluate landscape conditions and assess whether landscape characteristics including vulnerability to insect infestation have departed from historic and/or future ranges of variability. EMDS modeling of photo interpreted data was used to characterize the vulnerability of vegetation polygons to infestation by the Douglas-fir bark beetle in each sub-watershed. Douglas-fir bark beetle vulnerability was classified into three categories (high, moderate, or low) based on site quality, host abundance, canopy structure, stand density, host age, and host patch connectivity of vegetation polygons (Hessburg et al. 1999a, USDA 2012). This rating is used to evaluate how vulnerable a landscape is to the propagation of Douglas-fir bark beetle and shows how insect habitat has changed over time in its amount and configuration. Each vulnerability class was measured by the percentage of the landscape to indicate the overall amount present on the landscape.

Estimating the change in Douglas-fir bark beetle vulnerability based on treatment effects is complex, and the methods considered yielded little or no detectable difference between existing and post treatment EMDS modeledvalues. Based on professional judgement, it was determined that these methods underestimated treatment effects and using EMDS generated data would not accurately describe meaningful differences between alternatives. Acres treated to reduce Douglas-fir bark beetle vulnerability in each vulnerability classwill be used in this analysis to measure the effects of alternatives.

Resource Indicator: Forest vegetation vulnerable to dwarf mistletoe infection.

EMDS modelling was not used directly to estimate and measure forest vegetation vulnerable to Douglas-fir dwarf mistletoe infection. Photo interpreted and EMDS modelled data; however, were used to provide an estimate of the extent of Douglas-fir dwarf mistletoe vulnerability in the Buttermilk Creek and Libby Creek sub-watersheds following data validation with field observations of dwarf mistletoe infection and local knowledge of the project area. Douglas-fir bark beetle (DFB) vulnerability was used as a surrogate for estimating the extent of dwarf mistletoe vulnerability in the project area. Factors affecting Douglas-fir dwarf mistletoe infection dynamics are very similar to factors used by EMDS to model DFB vulnerability (including site quality, host abundance, canopy structure, stand density, and host patch connectivity). DFB vulnerability was adjusted by including dry forest areas located below 5,001 feet elevation with a high or moderate DFB hazard rating and moist forest areas below 5,001 feet elevation with a high DFB hazard rating to estimate the total area in each sub-watershed where forest vegetation is vulnerable to Douglas-fir dwarf mistletoe infection.The total acreage of treatment in the Libby Creek and Buttermilk Creek sub-watersheds to reduce vulnerability to Douglas-fir dwarf mistletoe infection and improve resilience to natural disturbances was used to measure the effects of alternatives.

Impact Level Definitions

The following definitions will be used to describe the types of impacts that would be caused by proposed actions analyzed in this report.

Type of Impact:

Adverse:The percentage of the landscape (PL) or average patch size (APS) classes moves away from the desired range of variability. There is an increase in the amount of vulnerability to western spruce budworm, Douglas-fir bark beetle, and dwarf mistletoe infection.

Beneficial: The percentage of the landscape (PL) or average patch size (APS) classes moves toward or stays within the desired range of variability. There is a decrease in the amount of vulnerability to western spruce budworm, Douglas-fir bark beetle, and dwarf mistletoe infection.

Duration of Impact:

- Short-term: Impact lasts up to 20 years.
- Long-term: Impact lasts more than 20 years.

Intensity of Impact:

- None: No impacts
- Negligible:Undetectable but measureablechange to forest vegetation composition and structure or resilience to biotic natural disturbances in each sub-watershed; less than1% change in PL, less than 10% change in APS, or less 10% area treated for Douglas-fir bark beetle or dwarf mistletoe vulnerability.
- Minor: Slightly noticeable, localized effects to forest vegetation composition and structure or resilience to biotic natural disturbances between 1 and 25%PL or 11 and 25% APS in each sub-watershed.
- Moderate: Apparent change in plant community structure, composition, or fuels that shifts ecological functions over approximately 26-50% in each sub-watershed.
- Major: Substantial change in plant community structure, composition, and/or fuels that shifts ecological function acrossthe majorityof each sub-watershed.

Affected Environment

Resource indicator: The amount and arrangement of dry and moist forest vegetation structures compared to the desired range of variability.

Overview of dry and moist forest structures

Land management practices during most of the twentieth century, including wildfire suppression, timber harvest, and grazing, have contributed to changes in dry and moist forest structures and composition in the project area. These practices have altered the amount of dry and moist forest structures (successional stages) while reducing the abundance of large trees. Up until the 1990s, timber harvest focused on the selective removal of larger, fire tolerant trees over extensive areas and dispersed regeneration harvest treatments. Grazing practices prior to the 1970s are believed to have created favorable site conditions for the establishment of conifer regeneration. Fire suppression eliminated the historically dominant natural disturbance which reduced tree density and influenced structural development and species composition over the majority of the project area (Hessburg et al. 2015). These practices favored the development of dense and often multiple canopy layered structures (SECC, UR, and YFMS) which currently are more abundant in the project area compared to estimated historic

levels in the dry forest type. Less dense, single canopy layer structures (SEOC and OFSS) in the dry and moist forest types generally are less abundant compared to estimated historic levels. Dry and moist forest structures with a high proportion of large overstory trees currently are present at very low levels compared to estimated historic conditions(OFMS) or not present at all (OFSS). Dry forest vegetation in the project area has been altered to a greater extent than moist forest vegetation with regard to the amount of individual structure classes currently present

Past land management practices favored the establishment and growth of shade tolerant conifers, including Douglas-fir and subalpine fir. Selective harvest of larger overstory trees, particularly ponderosa pines, promoted regeneration and release of understory Douglas-firs. Fire suppression maintained conditions that are favorable for the development of shade tolerant trees and unfavorable for the establishment and growth of shade intolerant conifers including ponderosa pines. Over time, the proportion of Douglas-fir stocking in dry and moist forest structures in the project area has increased compared to ponderosa pine stocking. Subalpine fir has become more prominent than Douglas-fir in moist forest structures in portions of the project area. Douglas-fir and subalpine fir are less fire tolerant than ponderosa pine, and management practices have favored the development of less fire tolerant forest structures comprised of dense and multiple canopy layers (SECC, UR, and YFMS) with a high proportion of relatively smaller and less fire tolerant trees. Fire tolerant forest structures (SEOC and OFSS) have become less abundant in the project area.

The spatial arrangement of dry and moist forest structures in the project area has also been affected by past management practices. Selective harvest of larger trees over extensive areas, dispersed regeneration harvest treatments, and fire suppression have contributed to the fragmentation of forest structures in the project area. The average patch size of all dry and moist forest structure classes in the project area currently are at the low end of the range or smaller than the estimated historic average patch size range indicating that current patch sizes in general are smaller compared to historic conditions. Figure 2displays current forest vegetation structures in the project area.

Restoration Strategy guidance implies that vegetation conditions including the amount and arrangement of dry and moist forest vegetation structures be maintained or restored to levels that are within ranges where the HRV and FRV overlap (the DRV) to provide for more sustainable and resilient forest ecosystems in the project area.

Buttermilk Creek Landscape

Dry forest structures occupy approximately 28% of the Buttermilk Creek landscape area.

Figure 3displays the percentage of the landscape and average patch size of dry forest structure classes currently present on the landscape. Restoration Strategy guidance states that vegetation conditions including forest vegetation composition and structure be maintained or restored to levels that are within ranges where the HRV and FRV overlap (the DRV) to provide for more sustainable and resilient forest ecosystems. The percentage of the landscape and average patch size of dry forest OFMS and OFSS structures are within the DRV for both measures; however, OFSS is at the minimum value for the desired ranges of variability. The percentage of the landscape of dry forest SECC, SI, UR, YFMS structure classes

are well above the DRV which is strong indication that these structure classes are overabundant on the landscape. The average patch size of dry forest SI and UR structure classes are within the DRV and the average patch size of dry forest SECC and YFMS are above the DRV. The percentage of the landscape and average patch size of dry forest SEOC structures are below the DRV indicating that this structure class is underrepresented in relatively small patches on the landscape. Based on current dry forest conditions, the Buttermilk landscape evaluation determined there is a restoration need to reduce the amount of area of dry forest SECC, SI, UR, and especially YFMS structures on the landscape and reduce the average patch size of dry forest SECC and YFMS structures. Additional dry forest restoration needs include increasing the amount of area and average patch size of dry forest SEOC and OFSS structures.

Moist forest structures occupy approximately 8% of the Buttermilk Creek landscape area.

Figure 3displays the percentage of the landscape and average patch size of moist forest structure classes currently present on the landscape. The percentage of the landscape and average patch size of moist forest OFMS and OFSS structures are within the DRV for both measures; however, they are present at levels which are at or near (OFSS and OFMS respectively) the minimum value for the desired range of variability. The percentage of the landscape of moist forest SECC, UR, and YFMS structure classes are within the DRV and the average patch size of moist forest SECC and YFMS structures are within the DRV. The average patch size of moist forest UR structures is below the DRV. The percentage of the landscape and average patch size of moist forest SEOC and SI structures are below the DRV indicating they are underrepresented in relatively small patches on the landscape. Based on current moist forest conditions, the Buttermilk landscape evaluation determined there is a restoration need to increase the amount of area and average patch size of moist forest SEOC, OFMS, and OFSS structure classes.

Libby Creek Landscape

Dry forest structures occupy approximately 46% of the Libby Creek landscape area.

Figure 3displays the percentage of the landscape and average patch size of dry forest structure classes currently present on the landscape. Restoration Strategy guidance states that vegetation conditions including forest vegetation composition and structure be maintained or restored to levels that are within ranges where the HRV and FRV overlap (the DRV) to provide for more sustainable and resilient forest ecosystems. The percentage of the landscape and average patch size of dry forest OFMS and OFSS structures are within the DRV for both measures; however, they are present at levels which are at or near (OFSS and OFMS respectively) the minimum for the desired range of variability. The percentage of the landscape of dry forest UR structure is above the DRV and the amount of dry forest SECC and YFMS structure classes are well above the DRV which is strong indication that that dry forest SECC and YFMS structures are overabundant on the landscape. The average patch size of dry forest UR, SECC, and YFMS are within the DRV. The percentage of the landscape and average patch size of dry forest SI are within the DRV; however, the average patch size is near the minimum value for the desired range of variability. The percentage of the landscape for dry forest SEOC is within the DRV and the average patch size is below the DRV. Based on current dry forest conditions, the Libby Creek landscape evaluation determined there is a restoration need to reduce the amount of dry forest UR, SECC, and YFMS structures on the landscape and to consolidate dry forest SEOC and SI structures into larger patches,

increasing the amount of SEOC and SI area on the landscape as needed. Additional dry forest restoration needs include increasing the amount of area and average patch size of dry forest SEOC and OFSS structures.

Moist forest structures occupy approximately 11% of the Libby Creek landscape area.

Figure 3displays the percentage of the landscape and average patch size of moist forest structure classes currently present on the landscape. The percentage of the landscape and average patch size of moist forest OFMS and OFSS structures are within the DRV for both measures; however, they are present at levels which are at or near (OFSS and OFMS respectively) the minimum value for the desired range of variability. The percentage of the landscape of moist forest SECC, SI, UR, and YFMS structure classes are within the DRV. The average patch size for moist forest SECC and YFMS are within the DRV. The average patch size for most forest SI and UR are below the DRV. The percentage of the landscape and average patch size of moist forest SEOC structures are below the DRV indicating that moist forest SEOC is underrepresented in relatively small patches on the landscape. Based on current moist forest conditions, the Libby Creek landscape evaluation determined there is a restoration need to increase the amount of area and average patch size of moist forest SEOC structures on the landscape while reducing the amount of YFMS area as needed. Additional moist forest restoration needs include increasing the amount of area and average patch size of moist forest OFSS structures and to a lesser extent OFMS structures on the landscape.

Resource Indicator: Forest patches with large and medium size trees.

Overview of forest patches with large and medium size trees.

Large and medium size trees are important elements of forest vegetation composition. Large trees (greater than 25 inches dbh) commonly are old trees with an estimated age of 150 years and greater because of the time required to attain this size in the project area. As old forest or remnant trees, many large old trees, particularly ponderosa pines and Douglas-firs, historically were resistant to wildfires, survived periods of extended drought, provided seed and genetic resources spanning centuries of varying climatic conditions, and contributed important snag and cavity habitat after they died (Hessburg et al. 2015). Large trees play an important role in post-fire recovery processes including a seed source for regeneration provided by surviving trees and dead trees which provide a source of snags and down logs which ameliorate post-fire site conditions for vegetation reestablishment and add carbon to the soil. Larger medium size trees (21 to 25 inches dbh) are important because they commonly are the largest trees present in forest structures in the project area and are the best candidates for developing into large size trees in the future.

Historically, large trees were more common in the project area where they dominated the overstories of open and closed canopy, old forest structure patches and were present as remnant overstory trees in other structure classes across a larger portion of the project area (Hessburg et al. 2015). Land management practices during most of the twentieth century have reduced the abundance of OFMS and OFSS structures and remnant large trees distributed throughout the project area in other structure classes. Forest patches with large overstory trees and understory trees less than 16 inches dbh in the

project area currently are within the DRV; however they are present at levels which trend toward the lower end of the desired range of variability in both landscapes. Past management practices have favored the development of dense and often multiple canopy layered structures in portions of the project area and this has affected existing large trees. Large trees are now typically competing for soil nutrients and water with higher levels of smaller and younger trees compared to historic conditions, which increases the risk of large tree mortality caused by bark beetle attacks. Increased stand density and inter-tree competition also reduces the likelihood of larger medium size trees from developing into large trees. Large trees and larger medium size trees currently are located in landscapes with higher levels of fire intolerant forest structures and are more likely to be growing in less fire tolerant patches compared to historic conditions which increases the likelihood of wildfires that could eliminate large trees and larger medium size trees. Other factors that affect the development and survival of large and medium trees are Douglas-fir dwarf mistletoe infestations and predation by western spruce budworm. Figure 4displays forest patches with large and medium size trees and old forest multistory structure patches currently present in the project area.

Buttermilk Creek Landscape

Forest patches with medium size overstory trees 16 to 25 inches dbh comprise an estimated 14,867 acres in the Buttermilk Creek landscape.

Figure 3displays the amount of area (acres available) of forest patches with medium, large, or medium and large trees in the landscape. This represents approximately 63% of the landscape, which for perspective purposes only is well above the desired range of variability of 24% to 28%. A majority of these patches are located in the Sawtooth Wilderness or are found in the steeper, less accessible parts of the landscape.

Forest patches with large overstory trees and understory trees smaller than 16 inches dbh comprise an estimated 2,391 acres in the Buttermilk Creek landscape. This represents approximately 10% of the landscape, which again for perspective purposes only is within the desired range of variability of 5% to 29%.

Forest patches with large overstory trees and medium size understory trees comprise an estimated 640 acres in the Buttermilk Creek landscape. This represents approximately 3% of the landscape, which for perspective purposes, is slightly above the desired range of variability of 0% to 2%.

Based on current conditions of forest patches with large and medium trees present, the Buttermilk Creek landscape evaluation determined there is a need to reduce the area of patches with medium size overstory trees and to maintain or increase the area of patches with large size trees (large overstory trees and understory trees less than 16 inches dbh).

Libby Creek Landscape

Forest patches with medium size overstory trees 16 to 25 inches dbh comprise an estimated 8,142 acres in the Libby Creek landscape.

Figure 3displays the amount of area (acres available) of forest patches with medium, large, or medium and large trees in the landscape. This represents approximately 31% of the landscape, which for perspective purposes only is within the desired range of variability of 24% to 58%.

Forest patches with large overstory trees and understory trees smaller than 16 inches dbh comprise an estimated 321 acres in the Libby Creek landscape. This represents approximately 1.2% of the landscape, which again for perspective purposes only is within the desired range of variability of 0.7% to 28%.

Forest patches with large overstory trees and medium size understory trees currently are not present in the Libby Creek landscape. Once again for perspective purposes only this level is within the desired range of variability of 0% to 8%.

Based on current conditions of forest patches with large and medium trees present, the Libby Creek landscape evaluation determined there is a need to increase the area in all structure classes with large trees, and thus a need to maintain existing large trees and restore large trees in patches with medium, large, or large and medium size trees.

Resource Indicator: Western spruce budworm vulnerability compared to the desired range of variability.

Overview of western spruce budworm vulnerability

Natural disturbances including insect infestations influence forest vegetation successional patterns including structure and composition. Current insect patterns in the project area are the by-product of the effects of human action and altered disturbance regimes which are being driven by a warmer climate (Hessburg et al. 2015). Past management practices, including fire suppression and selective harvesting of larger trees, have favored the development of densely stocked and multiple canopy layered stand structures with a high proportion of Douglas-fir stocking in the overstory and understory canopy layers in portions the project area. Douglas-fir is the preferred host of the western spruce budworm in the project area and densely stocked forest patches with Douglas-fir trees in the upper and lower canopy layers are highly vulnerable to western spruce budworm defoliation (Carlson et al. 1985 and Hessburg et al, 1999a). Repeated defoliation of host trees causes reduced tree growth, top kill, and mortality of trees. The majority of trees killed by defoliation are smaller understory trees; however, larger and typically older Douglas-fir trees are predisposed to fatal Douglas-fir bark beetle attacks by repeated defoliation. Restoration Strategy guidance implies that vegetation conditions including vulnerability to western spruce budworm infestation be maintained or restored to levels that are within ranges where the HRV and FRV overlap (the DRV) to provide for more sustainable and resilient forest ecosystems in the project area.

Figure 3displays the percentage of the landscape with low, moderate, and high western spruce budworm vulnerability currently present in the project area.

Buttermilk Creek Landscape

Existing conditions in the Buttermilk landscape indicate the amount of area with low vulnerability to western spruce budworm infestation is below the DRV and underrepresented on the landscape. The amount of area with moderate vulnerability is within the DRV and present at a level that is close to the minimum value for the desired range of variability. The amount of area with high vulnerability is well above the DRV indicating that this vulnerability class is overabundant on the landscape.

Based on current conditions, the Buttermilk landscape evaluation determined there is a restoration need to increase the amount of area with low western budworm vulnerability and to decrease the amount of area with high western budworm vulnerability on the landscape.

Libby Creek Landscape

Existing conditions in the Libby landscape indicate the percentage of the landscape with low vulnerability to western spruce budworm infestation is above the DRV and possibly overabundant on the landscape. The Libby Creek landscape; however has an unusually large portion of non-forested shrub land vegetation (approximately 20% of the landscape) which is classified low vulnerability and skews the estimate of the percentage of the landscape with low vulnerability. Current estimates of the percentage of the landscape with moderate and high western spruce vulnerability are within the DRV. There is a high degree of fragmentation of patches in all vulnerability classes with a high proportion of relatively small size patches distributed throughout the landscape. Many of these smaller patches, however are located in unroaded areas and areas which are low priority for treatment to maintain or restore dry and moist forest structures and/or fuel reduction.

Based on current conditions, and restoration priorities, the project management team has determined that there is a need to maintain the percentage of the landscape with high vulnerability to western spruce budworm infestation within the lower half of the DRV.

Resource Indicator: Forest vegetation vulnerable Douglas-fir bark beetles.

Overview of Douglas-fir bark beetle vulnerability

Douglas-fir bark beetle infestations are another form of natural disturbance which can affect forest vegetation successional patterns including structure and composition. Douglas-fir bark beetles are opportunistic and they typically attack low vigor Douglas-fir trees weakened by stress caused by disease, inter-tree competition, and drought, or by disturbances such asdefoliation, fire injury, snow breakage, or blowdown. Factors affecting Douglas-fir beetle vulnerability include host abundance, number of canopy layers, stand density, host age and host patch connectivity, and as these values increase so does the risk rating. Medium and large size trees greater than 120 years old are more likely to be attacked. Past management practices have promoted the development of densely stocked and multiple canopy layered stand structures with high proportion of Douglas-fir stocking in the overstory and understory canopy layers in portions of the project area. These factors contribute to high risk of bark beetle attack primarily in relatively older medium and large size Douglas-fir trees in these areas.

In the Buttermilk Creek landscape, there are an estimated 6,061 acres with moderate vulnerability and 4,463 acres with high vulnerability to Douglas-fir bark beetle infestation. In the Libby Creek landscape there are an estimated 11,820 acres with moderate vulnerability and 2,532 acres with high vulnerability to Douglas-fir bark beetle infestation.

Resource Indicator: Forest vegetation vulnerable to dwarf mistletoe infection

Natural disturbances including tree diseases influence forest vegetation successional patterns including structure and composition. Dwarf mistletoe is a genus of parasitic plant that drastically affects growth patterns and health of Douglas-fir host trees as well as many other conifers. Douglas-fir dwarf mistletoe infects only Douglas-fir and it is the primary disease of concern in the project area. This species is native and has always been part of the eastern Washington landscape, but as a relatively minor component of forest patches (stands). Historically Douglas-fir dwarf mistletoe was widely distributed in the project area with little intensification. Dwarf mistletoe infections were confined to larger fire resistant trees located in patches, groups, or individual trees that were widely scattered throughout the project area or concentrated in riparian areas that rarely burned. Spread of the disease was limited by the influence of frequent low intensity fire that maintained more open stand structures with a high proportion of ponderosa pine and other non-host species (Hessburg and Mitchell 1994). Management practices during most of the twentieth century, including fire exclusion and selective harvesting, have favored the development of dense and often multiple canopy layered structures with a high proportion of Douglas-fir stocking in the overstory and understory canopy layers. Infection has intensified and spread from infected overstory trees into susceptible understory trees resulting in current infection levels that exceed historic levels of this disease.

There are approximately 6,349 acres within the Buttermilk Creek landscape and 10,941 acres within Libby Creek landscape that have been determined to be infected and/or vulnerable to Douglas-fir dwarf mistletoe infection. Dwarf mistletoe infection rate is not a forest vegetation characteristic that can be determined by aerial photo interpretation and analyzed with EMDS, so it is unknown if the level of dwarf mistletoe infection in the project area is within the HRV for the landscape level. Figure 5displays the extent of forest vegetation vulnerable to dwarf mistletoe infection in the project area.

Figure 2. Existing vegetation structure for the project area.

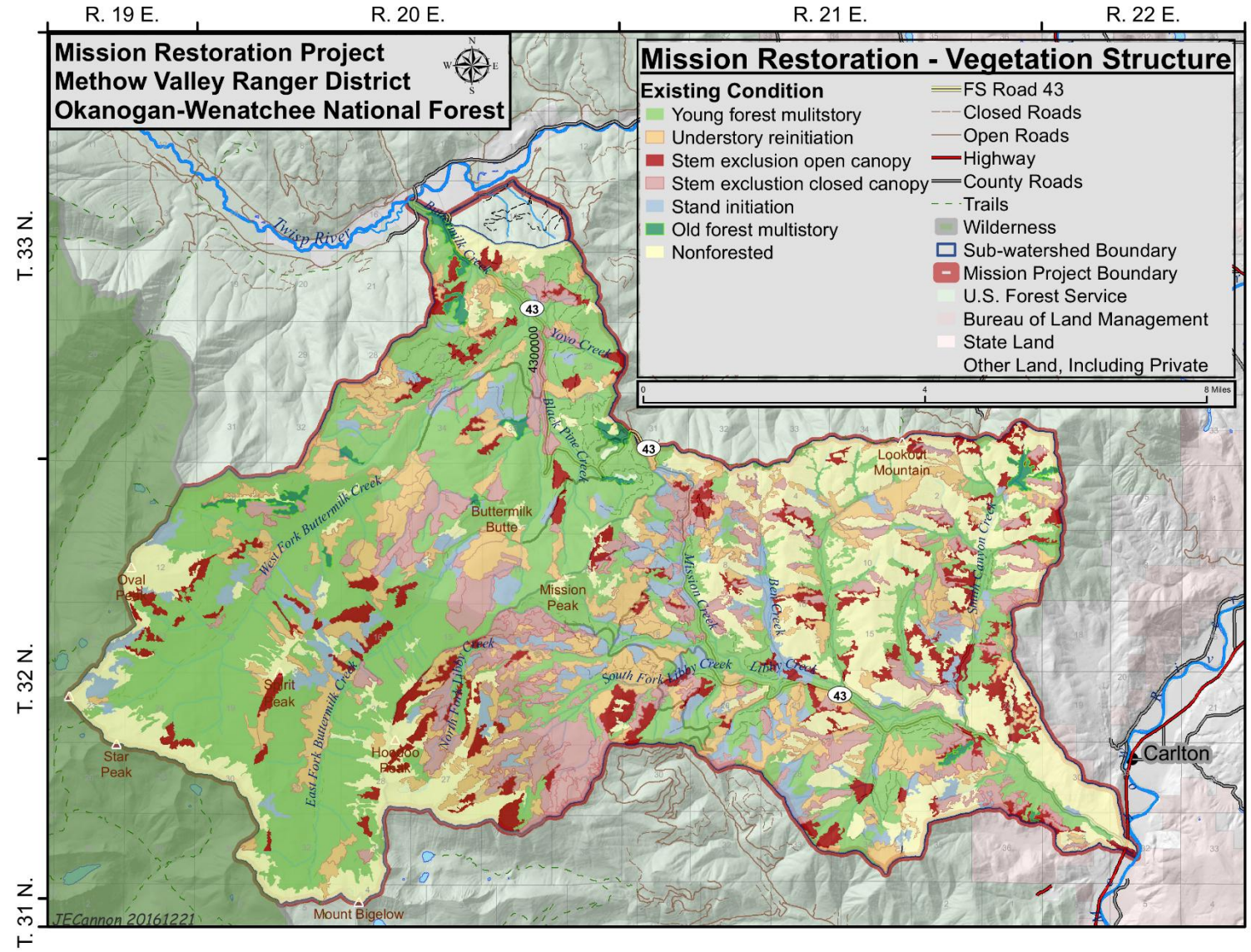

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Figure 3. Resource Indicators and Measures for the Existing Condition and Effects

Resource Element	Resource Indicator	Measure	Existing Condition (and effects of Alternative 1)		
Restoration or maintenance of Forest Vegetation Composition and Structure.	The amount and arrangement of dry and moist forest structures compared to the desired range of variability.	Percentage of the Buttermilk and Libby Creek landscapes occupied by dry and moist forest structures.	**Dry Forest**		
			Structure	**Buttermilk**	**Libby**
			OFMS	1.4% -Within DRV of 0-2.3%	0.04% Within DRV of 0-2.3%
			OFSS	0% Within DRV of 0-2.6%	0% Within DRV of 0-0.9%
			SECC	1.4% **Above** DRV of 0-0.3%	8.0% **Above** DRV of 0-0.8%
			SEOC	2.1% **Below** DRV of 3.5-6.6%	6.1% Within DRV of 3.5-17.4%
			SI	1.4% **Above** DRV of 0-0.5%	5.2% Within DRV of 0-10%
			UR	3.2% **Above** DRV of 0-2.3%	11.0% **Above** DRV of 0.2-9.9%
			YFMS	18.6% **Above** DRV of 0-1.7%	14.0% **Above** DRV of 0-9.1%
			Moist Forest		
			Structure	**Buttermilk**	**Libby**
			OFMS	0.5% Within DRV of 0-5.6%	0.5% Within DRV of 0-11.2%
			OFSS	0% Within DRV of 0-5.3%	0% Within DRV of 0-3.0%
			SECC	1.4% Within DRV of 0.4-5.6%	0.8% Within DRV of 0-5%
		.	**SEOC**	0.2% **Below** DRV of 2.5-12.3%	0.4% **Below** DRV of 2.5-12.3%
			SI	0.3% **Below** DRV of 0.9-8.9%	1.4% Within DRV of 0.9-9.9%
			UR	1.3% Within DRV of 1-10.3%	1.2% Within DRV of 1-18.4%
			YFMS	4.1% Within DRV of 0.7-8.4%	6.0% Within DRV of 0-18.1%
		Average patch size of dry and moist forest structures in the Buttermilk and Libby landscapes	**Dry Forest**		
			Structure	**Buttermilk**	**Libby**
			OFMS	68 ac. Within DRV of 0-340 ac	10 ac. Within DRV of 0-318 ac
			OFSS	0 ac. Within DRV of 0-168 ac	0 ac. Within DRV of 0-159 ac
Restoration or maintenance of	The amount and arrangement of dry and moist		**SECC**	54 ac **Above** DRV of 0-36 ac	35 ac. Within DRV of 0-89 ac
			SEOC	29 ac **Below** DRV of 52-267	15 ac. **Below** DRV of 21-315 ac

Resource Element	Resource Indicator	Measure	Existing Condition (and effects of Alternative 1)		
Forest Vegetation Composition and Structure.	forest structures compared to the desired range of variability.	Average patch size of dry and moist forest structures in the Buttermilk and Libby landscapes. (acres)	**SI**	29 ac. Within DRV of 0-90 ac	24 ac. Within DRV of 0-246 ac
			UR	47 ac. Within DRV of 0-137 ac	41 ac. Within DRV of 14-286 ac
			YFMS	200 ac. **Above** DRV of 0-183 ac	58 ac. Within DRV of 0-290 ac
			Moist Forest		
			Structure	**Buttermilk**	**Libby**
			OFMS	57 ac. Within DRV of 0-312 ac	27 ac. Within DRV of 0-348 ac
			OFSS	0 ac. Within DRV of 0-255 ac	0 ac. Within DRV of 0-213 ac
			SECC	68 ac. Within DRV of 42-927 ac	26 ac. Within DRV of 0-174 ac
			SEOC	37 ac. **Below** DRV of 50-249 ac	21 ac. **Below** DRV of 50-249 ac
			SI	31 ac. **Below** DRV of 32-177 ac	27 ac. **Below** DRV of 32-177 ac
			UR	39 ac. **Below** DRV of 68-246 ac	19 ac. **Below** DRV of 68-383 ac
			YFMS	74 ac. Within DRV of 46-363 ac	82 ac. Within DRV of 0-440 ac
	Forest patches with large and medium size trees.	Acres treated in the Buttermilk and Libby landscapes to maintain and restore large trees in patches with medium, large, or large and medium size trees.	**Buttermilk**		**Libby**
			Medium Trees – 14,867 ac available Large Trees - 2,391 ac available Large and Medium – 640 ac available		Medium Trees – 8,142 acres available Large Trees – 321 acres available Large and Medium – 0 acres available
Resilience to biotic natural disturbances.	Western spruce budworm vulnerability compared to the desired range of	Percentage of the Buttermilk and Libby Creek landscapes with high, moderate,			
			Risk	**Buttermilk**	**Libby**
			Low	15% **Below** DRV of 22-28%	32% **Above** DRV of 12-28%
			Moderate	15% Within DRV of 13-33%	11% Within DRV of 8-27%

Resource Element	Resource Indicator	Measure	Existing Condition (and effects of Alternative 1)		
	variability.	and low risk.	High	69% **Above** DRV of 31-52%	57%Within DRV of 29-74% But not within lower half of DRV
	Forest vegetation vulnerable to Douglas-fir bark beetles.	Acres of treatment in the Buttermilk and Libby landscapes with high or moderate risk.	Moderate - 6,061 acres available High - 4,463 acres available		Moderate - 11,820 acres available High - 2,532 acres available
	Forest vegetation vulnerable to dwarf mistletoe infection.	Acres treated in the Buttermilk and Libby Creek landscapes to reduce vulnerability.	Buttermilk = 6,349 ac. Available		Libby = 10,961 ac. Available

Figure 4. Large and medium sized trees in project area with proposed actions displayed.

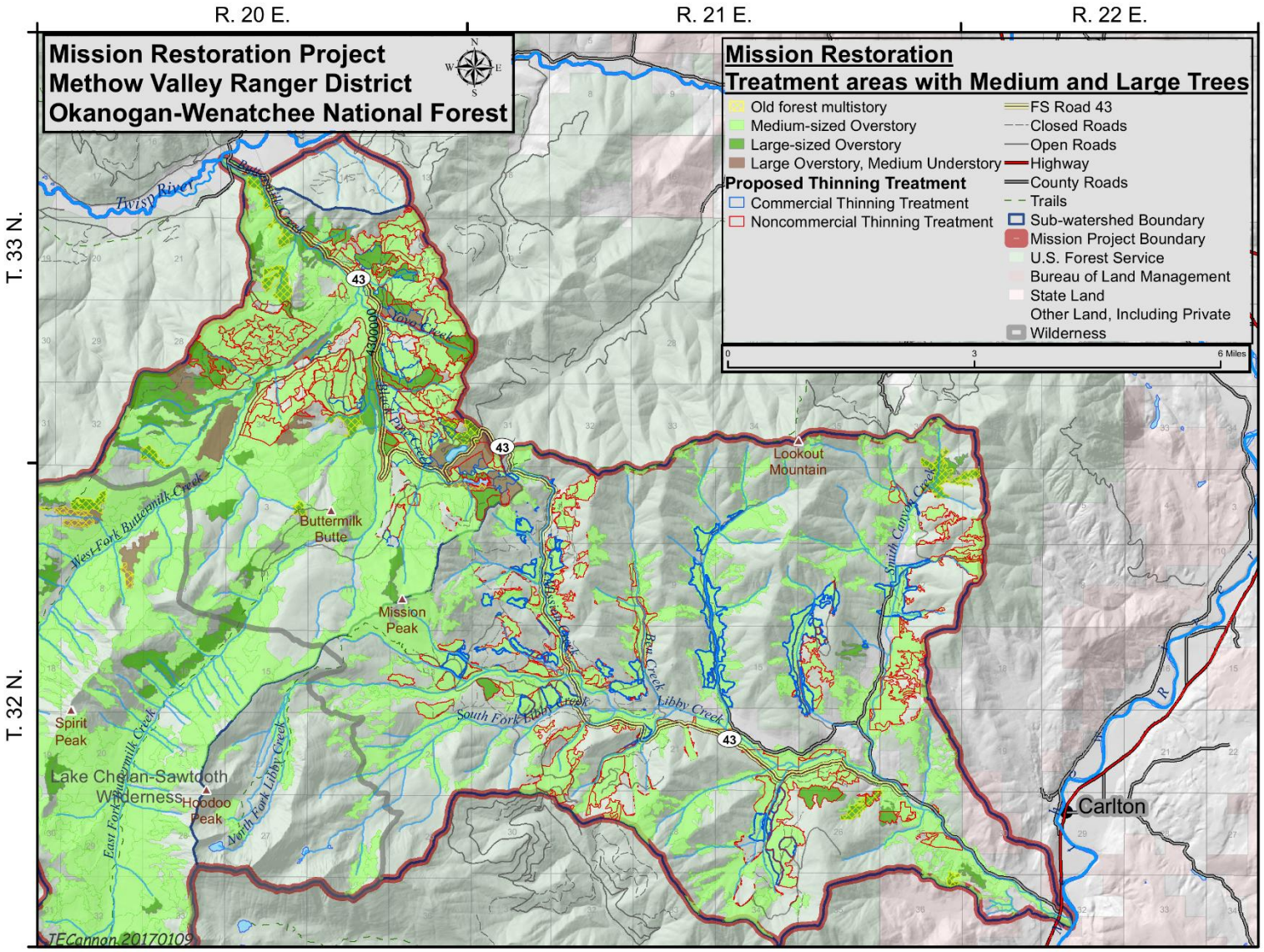
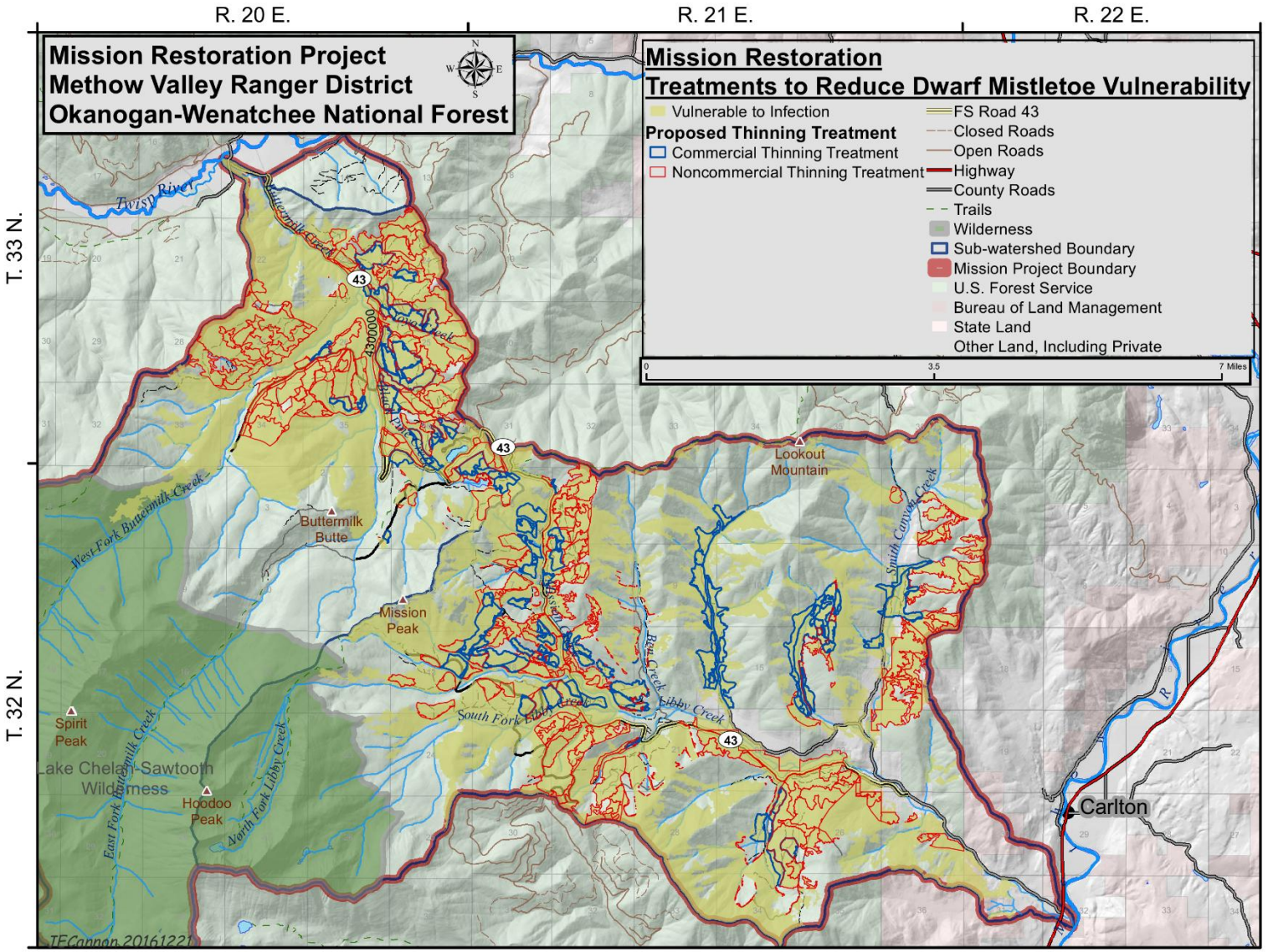


Figure 5. Area of vegetation vulnerable to dwarf mistletoe in the project with proposed actions displayed.



Environmental Consequences

Alternative 1 – No Action

Resource indicator: The amount and arrangement of dry and moist forest vegetation structures compared to the desired range of variability.

Under Alternative 1, there would be no immediate change in either dry or moist forest vegetation structures in either of the analyzed landscapes. The Percent Landscape (PL) and Average Patch Size (APS) departures for forest structure in moist and dry forest types identified in the Affected Environment section would persist until either new disturbance (fire, defoliation or windthrow) or tree growth put patches in new structure categories. Within the next 20 years(short term), without any man caused or natural disturbances, understory canopies would continue to develop and the percent landscape and perhaps the average patch size of the single storied and/or open stand structures (SI, SEOC and OFSS) would be reduced fairly dramatically (minor), such that where these are currently within DRV, they would likely drop below DRV and if they are currently below HRV, they would stay there until a disturbance takes place (long term). These structure types would evolve to more complex structure types (UR, YFMS and OFMS) such that that if these types are currently below the Desired Range of Variability (DRV), they could go toward or land within DRV within the next 20 years, while if they are currently over DRV they would likely continue to be above until a disturbance takes place(see

Figure 3 for details).SEEC patches, which tend to grow fairly slowly because of tree to tree competition are likely to stay as they are for at least the next 20 years or until the next disturbance.

The effects of these departures on Medium and Large trees, insect vulnerabilities, fire resiliency, and wildlife habitat will be addressed elsewhere in the Mission Restoration Project EA.

Resource Indicator: Forest patches with large and medium size trees

Under the no action alternative there would be no overstory and understory treatments. There would be no reduction ofinter-tree competition, no reduction in vulnerability to bark beetles, western spruce budworm,or Douglas-fir dwarf mistletoe; and no increase of resiliency to fire; all of which would benefit large and medium sized trees. There would be no immediate change in the area of patches with medium and large tree components. However, under drought conditions and especially in conjunction with insect defoliation, dwarf mistletoe or root disease infection, it is very common for the largest trees in a densely stocked stand to succumb to bark beetles. Multiple tree canopy layers and buildup of surface and ladder fuels can contribute to undesired large and medium size tree mortality in the event of wildfire. If enough large and medium sized trees die, then stands that currently are regarded as stands that contain medium and large trees could lose this attribute. Without thinning younger stands, it would take longer, up to twice as long, for individual trees within these young stands to promote into medium and large size classes.This adverse effect would last until these patches are actively managed, which based on the average length of time to return to a planning area, could be up to 20 years (short term) and it is likely for the Percent Landscape with medium and/or large trees to be reduced by one percent during that time frame with possibilities of much higher impact.

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Resource Indicator: Western spruce budworm vulnerability compared to the desired range of variability.

Under Alternative 1, there would be no immediate change in western spruce budworm vulnerability levels in both landscapes within the project area.In the short term, vulnerability levels would remain relatively static for approximately 20 years.

In the Buttermilk landscape, the percentage of the landscape (PL) with low risk of defoliation would remain below the DRV, the PL with moderate risk would remain within the DRV, and the PL with high risk would continue to remain well above the DRV. The adverse effects to Low and High categories would last until these patches are actively managed. Overall, these conditions would contribute to an adverse, short term, negligible effect on western spruce budworm vulnerability in the Buttermilk Creek landscape.

In the Libby Creek landscape, the percentage of the landscape (PL) with low risk of defoliation would remain above the DRV for the next 20 years; however, as described previously in the Affected Environment description, this measure is skewed by the unusually high amount of non-forested shrub-land vegetation present in the landscape. The PL with moderate risk would remain within DRV and high risk of defoliation would remain above the lower half of DRV. The effects, for the next 20 years would be adverse, short-term and negligible.

Over the long term, western spruce budworm vulnerability would change in the project area with no action. Factors affecting vulnerability to defoliation include host abundance, number of canopy layers, stand density, and host patch connectivity, and as these values increase so does the risk of defoliation. Douglas-fir stocking levels in the project area would be expected to increase in all canopy layers primarily in the dry and moist forest vegetation types. Forest structures with multiple canopy layers and a high proportion of Douglas-fir stocking in all layers would increase as would the total area with high risk of defoliation. This increase in high risk would come from areas currently rated as moderate risk for defoliation. The total area with low risk of defoliation would decrease as some areas currently with low risk rating change to moderate risk. The total area with moderate risk would change based on the net effect of recruitment from current low risk patches and the loss of moderate risk patches which develop into high risk.

Resource Indicator: Forest vegetation vulnerable Douglas-fir bark beetles.

Under Alternative 1, there would be no reduction of forest vegetation vulnerability to Douglas-fir bark beetle (DFBB) attacks on the 17,881 acres with moderate risk and the 6,985 acres with high risk in the project area. Forest vegetation conditions affecting DFBB vulnerability including host abundance, number of canopy layers, stand density, host age, and host patch connectivity would persist or increase over time in the project area. The amount of area with high risk would increase as Douglas-fir stocking levels and multiple canopy layer structures increase in areas which currently are rated as moderate risk. Low vigor medium and large trees in high and moderate risk areas would remain vulnerable to fatal bark beetle attacks. As Douglas-firs which regenerated or were released from competition by selective harvesting during the past century mature and become older than 120 years, the amount of susceptible

trees would increase, further contributing to Douglas-fir bark beetle vulnerability in the project area.The effects of no action would last until the next opportunity to manage, which may be up to 20 years. Overall, these conditions would contribute to an adverse, short-term, minoreffecton the reduction of DFBB vulnerability in the Buttermilk Creek and Libby Creek landscapes. However, with such a high proportion of the area in High vulnerability to DFBB, should an epidemic of Douglas-fir bark beetle take place within the project area, there would likely be an increased wildfire risk until the epidemic wanes and the levels of resulting red and fine fuels have subsided. If a wildfire should take place during this extremely vulnerable condition, it could have adverse, long term, major effects on medium and large Douglas-fir trees. Thecurrent potential for DFBB epidemic is fairly high due to recent defoliation and drought.

Resource Indicator: Forest vegetation vulnerable to dwarf mistletoe infection.

Under Alternative 1, there would be no reduction of dwarf mistletoe vulnerability on the 17,310 acres of forest vegetation vulnerable to infection within the project area.

Douglas-fir dwarf mistletoe (DFDM) vulnerability factors are presence of DFDM in or near a stand, presence of the host species (Douglas-fir), high proportions of the host species, and multiple canopy layers of the host species (Hessburg et al. 1999a). There would be no reduction of any of these factors under Alternative 1. It is not likely that the acres of stands vulnerable to DFDM would increase more than one percent. Therefore, the effects of no treatment on the acres of the project area vulnerable to DFDM would be adverse, short-term and negligible. However, the effect of no treatment would result in a deterioration of tree and patch health that would be adverse, long-term and moderate.

Within stands that are currently infected with DFDM, within tree infection levels would increase and tree to tree infection would continue, especially in stands with multiple canopies of Douglas-fir which facilitates seed dispersal. Seeds are ejected to up to 50 feet from fruiting DFDM plants. DFDM would spread more slowly through stands that have a low proportion of Douglas-fir or are single storied stands. An average rate of DFDM movement through a stand is 1-2 feet per year (Washington State University Forestry Extension). Any intensification of disease within a tree or a patch is irreversible and long term without active management.

In the many stands that have low intensities of infection, there would be little effect to the ability of the stands to achieve large diameter tree status. Severe levels (number of trees infected) and intensities (proportion of the tree infected) of dwarf mistletoe can change the trajectory and potential of stand development. The average diameter growth rate is reduced by half with severe infections (Hawksworth and Wiens 1996). Poor diameter growth in Douglas-fir trees results in higher risk to bark beetle attack and exacerbates the effects of root disease in drought conditions (P. Nash, USFS, personal communication). This early mortality reduces the length of time that mature and complex stand structures are on site. Dwarf mistletoe infection in younger stands is likely to reduce the potential for these stands to attain desired structure classes (Geils and Mathiasen 1990).

Heavy masses of foliage and small branches (brooms) that are caused by the parasitic plants increase bulk crown density and are likely to hang low to the ground or break off and lay at the base of the tree,

forming ladder and ground fuels. These brooms are especially flammable due to the dead material that accumulates within, the abundance of fine branches and the concentration of resins. Stands with severelevels and intensity of dwarf mistletoe are at higher risk to crown fires than similar, uninfected stands. (Schmitt 2000)

Alternatives 2 and 3

Proposed Action Effects Common to Both Action Alternatives

Proposed overstory thinning and noncommercial thinning vegetation treatments to affect the amount and arrangement of dry and moist forest structures, forest patches with large and medium size trees, and western spruce budworm vulnerability, forest vegetation vulnerable to Douglas-fir bark beetles, or forest vegetation vulnerable to dwarf mistletoe infection in the Buttermilk and Libby Creek landscapes are identical in Alternatives 2 and 3. The effects for both of these alternatives will be described in this section.

Proposed Actions Dismissed from Further Consideration

The following proposed actions will not be considered further in this analysis because they would have no measurable effect on the restoration or maintenance of the amount and arrangement of dry and moist forest structures, forest patches with large and medium size trees, western spruce budworm vulnerability, forest vegetation vulnerability to Douglas-fir bark beetles, or forest vegetation vulnerability to dwarf mistletoe infection in the Buttermilk and Libby Creek landscapes: fuels reduction treatments in the Buttermilk Annex area, soil restoration, rock armoring, replacing undersized culverts or installing fish culverts, beaver habitat enhancement, coarse woody debris enhancement, or creating hardened fords.

Project Design Features and Mitigation Measures

Figure 6. Design Features

Number	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
Vegetation Management				
	Avoid mechanical damage to the boles, live branches, and terminal leaders of designated residual trees during harvest and young plantation thinning operations.	Damage to residual trees can have a detrimental effect on the growth and long term viability of residual trees intended to remain following treatment.	High	Vegetation management treatment objectives may not be fully accomplished.
	Protect boles, crowns, and roots of genetic select trees from damage during harvest and fuels treatment operations.	The establishment and maintenance of each genetic select tree represents a substantial monetary investment. Damage to the boles, crowns, and roots is detrimental to the survival, growth, and long term viability of genetic select trees.	High	Damage leading to the mortality or reduced seed production of a select tree represents a lost opportunity for genetically diverse seed collection to support reforestation projects.
	Retain five to 10 suitable breeding partners within 120 feet of genetic select trees. Suitable breeding partners include vigorous, disease-free, well-formed, and cone producing trees 12” DBH and larger which are the same species of a select tree.	Genetic select trees require pollen from nearby trees of the same species to produce cone crops with viable seed. Suitable breeding partners possess desirable heritable traits which may be passed on through pollen to seed produced by genetic select trees. When available, seed produced by select trees is preferred to grow seedlings for tree planting in reforestation projects on the ranger district.	Moderate	Cone crops and viable seed production of genetic select trees may be reduced by inadequate pollination. Genetic quality of seedlings produced from select tree seed may be diminished.

Number	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
	Discourage livestock grazing in regeneration harvest units for a period of three to five years following tree planting with the following measures: • Avoid placing salt blocks in or adjacent to tree planting units. • Avoid seeding grass species that would encourage grazing (forage mix) in or adjacent to tree planting units.	Planted tree seedlings are susceptible to livestock trampling damage which can detrimentally affect seedling growth and survival during this time period. Heavy livestock use can disturb seedling survival and stocking plot markers and hinder required survival and stocking level monitoring efforts which are conducted for three to five years following planting.	Moderate	Seedling establishment may be detrimentally affected and desired tree stocking levels may not be promptly attained following planting.
	Limit openings in the forest canopy created by timber harvest in Dry Forest Restoration Thin, Dry Forest Thin with Dwarf Mistletoe Reduction, and Aspen Release treatment units.	Individual openings created by harvest in Dry Forest Restoration Thin treatments will be limited to a maximum size of one acre. Individual openings created by harvest in Aspen Release and Dry Forest Thin with Dwarf Mistletoe Reduction treatments will be limited to a maximum size of: • One acre in the visual foreground. • Two acres in all other areas.	High	Forest canopy openings may exceed desirable levels in visual foreground and other areas.
	Limit openings in the forest canopy created by timber harvest in Moist Forest Thin treatment units 1 and 65	Individual openings created by harvest will be limited to a maximum size of one quarter acre.	High	Forest canopy openings may exceed desirable levels for Northern Spotted Owl habitat.

Resource indicator: The amount and arrangement of dry and moist forest vegetation structures compared to the desired range of variability

Under Alternatives 2 and 3 a combination of overstory and understory treatment would result in changing or maintaining stand structure in many of the stands treated. For the most part, only overstory treatment combined with understory fuel treatments would have the potential of changing forest structure, while standalone fuels treatments are only seen to contribute towards maintenance of existing structures or contribute over the long term towards promotion of structures with larger diameter trees. Structure conversion treatments that would depend on the reduction of understory trees would have a duration of up to 20 years (short-term), at which point understory would have regenerated to the point that it would return to a multiple storied forest structure. Treatments that would result in conversion from SECC to other structures or the creation of SI (Variable Retention Regeneration harvest and post-harvest planting) would last 20-40 years (long-term) until tree growth moved the stands towards other forest structure types.The type, duration and intensity of impact are shown for each structure type in Figure 7 and a map of post-project vegetation structure is displayed in Figure 8. The planned treatments of overstory together with understory treatments would have a long-term effect and the stand-alone understory treatments would have a short term effect of promoting stands with medium and medium and large sized trees towards Old Forest characteristics.

Buttermilk Creek Landscape

Within the Buttermilk Creek Landscape, the planned treatments (655 acres of overstory treatments together with understory treatments as well as 3,138 acres of standalone fuels treatments) would result in creating 120 and 10 acres of SEOC stands within Dry and Moist forest by thinning SECC. 62 acres of SEOC would be created from thinning UR stands in Dry Forest. Thinning YFMS in Dry and Moist forest would result in 313 and 6 acres respectively. Within the Dry Forest, pre-commercial thinning would result in moving 34 acres of SI to SEOC and 46 acres of SI to YFMS. An equal amount of SI is expected to be created in response to fuels treatments that expose mineral soil in currently unforested areas. The remaining 122 acres of overstory treatment would contribute towards maintenance of existing SEOC and OFMS.

Dry Forest

This treatment would result in no immediate change in Percent Landscape (PL) for OFSS or OFMS in Dry forest, which are both within DRV. The PL for SEOC would be increased by 2.4% by converting SECC, UR and YFMS by 0.8, 0.1 and 1.5% respectively. This increase in SEOC would result in bringing this forest structure into the Desired Range of Variability (DRV). SECC, SI and YFMS would move towards DRV, while UR would be 0.1% further above DRV after treatment. While PL for OFSS and OFMS would remain unchanged, 29 acres of OFMS would be maintained through vegetation treatments and the planned 217 acres of overstory, together with understory treatments, would have a long-term effect while 464 acres of stand-alone understory treatments would have a short term effect of promoting medium and large sized trees.This would result in promoting patches towards Old Forest characteristics.

This treatment would result in no change in Average Patch Size (APS) for OFSS or OFMS, which are both within DRV. However, both of these Old Forest structures would be maintained or promoted by treatment that benefits or promotes medium and large trees, which would have an unknown effect on APS. The APS for SEOC would increase from 29 to 48 acres, but this metric is still below DRV. There would also be a fairly dramatic reduction of APS in YFMS by 44 acres, which would bring this metric to within DRV. The remaining structures would change more modestly. SECC would be reduced from an average of 48 acres per patch to 42 acres (remains within DRV). The APS for SI would be reduced from 29 to 23 acres (remains within DRV) and the APS for UR would increase from 47 to 57 acres (remains within DRV).

Moist Forest

This treatment would result in no immediate change in Percent Landscape (PL) for OFSS or OFMS within Moist Forest, which are both within DRV. The PL for SEOC would be increased by 0.2 to 0.2%, which would still be below DRV. There would be no change in SI andnegligible changes SECC and UR, leaving them within, below and within DRV respectively. While PL for OFSS and OFMS would remain unchanged, 17 acres of OFMS would be maintained through vegetation treatments and the planned 4 acres of overstory together with understory treatments would have a long-term effect while 99 acres of stand-alone understory treatments would have a short term effect of promoting medium and large sized trees, which in turn, would result in promoting patches towards Old Forest characteristics.

This treatment would result in no change in Average Patch Size (APS) for OFSS or OFMS, which are both within DRV. However, both of these Old Forest structures would be maintained or promoted by treatment that benefits or promotes medium and large trees, which would have an unknown effect on APS. The APS for SECC would increase from 68 to 107 acres, and would remain within DRV. The APS for SECC would increase from 37 to 52 acres, which would bring this metric within DRV. There would be no change the APS for SI, which would still be below DRV. There would also be reduction of APS in UR by 2 acres, bringing this metric further below DRV; and YFMS by 8 acres, which would still be within DRV.

Overall, combining the effects of 3,819 acres of planned treatment, which is 16 percent of the Buttermilk landscape, the effects would be beneficial and short-term with minor intensity on the Amount and Arrangement of Dry and Moist Forest Structures Size for the various structure types within the Buttermilk landscape

Libby Creek Landscape

Within the Libby Creek Landscape, the planned treatments (1,363 acres of overstory treatments together with understory treatments as well as 4,215 acres of standalone fuels treatments) would result in creating 1,077 acres of SEOC patches within Dry by thinning 165 acres of SECC, 259 acres of UR and 627 acres of YFMS and 75 acres of SI from YFMSwithin in Dry Forest. Treatments in Moist Forest would result in moving 126 acres of YFMS to SEOC structure. Thinning would result in moving 79 acres of Dry Forest YFMS to in order to consolidate existing SI patches, increase patch size, and reduce fragmentation of Dry forest SI patches in the landscape. The remaining 111 acres of overstory treatment contributed towards maintaining Northern Spotted Owl Habitat (22 acres) and maintenance of existing SEOC. 487

and 180 acres of SI in Dry and Moist Forest, respectively, would be treated through standalone understory treatment to promote future SEOC. Approximately 25 acres of moist OFMS would be maintained through understory fuels reduction.

Dry Forest

This treatment would result in no immediate change in Percent Landscape (PL) for OFSS or OFMS within Dry Forest, which would both remain within DRV. The PL changes for SEOC (up 5.8%-remains within) and YFMS (down 3.0%-remains below) would be the most dramatic. SECC would decrease by 1.5% from 8% and would remain within DRV. SI would increase by 1.2%, remaining within DRV and UR would decrease by 0.8% but still remain above DRV. While PL for OFSS and OFMS would remain unchanged, the planned 688 acres of overstory together with understory treatments would have a long-term effect while 1,766 acres of stand-alone understory treatments would have a short term effect of promoting medium and large sized trees, which in turn, would result in promoting patches towards Old Forest characteristics.

This treatment would result in no change in Average Patch Size (APS) for OFSS or OFMS, which are both within DRV. However, both of these Old Forest structures would be maintained or promoted by treatment that benefits or promotes medium and large trees, which would have an unknown effect on APS. There would be a modest decrease in SECC of 2 acres from 35 acres, which would leave this metric within DRV. The APS for SEOC would nearly double in size, going from 15 to 29 acres, which would bring this metric to within DRV. The APS for SI would also nearly double, going from 14 to 24 acres, but would remain within DRV. The APS for UR would decrease from 41 to 36, leaving this metric within DRV. The APS for YFMS would also decrease from 58 to 9 acres, also staying within DRV.

Moist Forest

The proposed treatment would result in no immediate change in Percent Landscape (PL) for OFSS or OFMS within Moist Forest, which would both remain within DRV. All of the changes in PL for the various structures would be modest, with the largest changed being an increase of 0.3% in SEOC, which would still have a PL below DRV. There would be no change in SECC and there would be a 0.1% decrease in SI, UR and YFMS, all of which would have PL metrics that remain within DRV. While PL for OFSS and OFMS would remain unchanged, the planned 135 acres of overstory together with understory treatments would have a long-term effect while 417 acres of stand-alone understory treatments would have a short term effect of promoting medium and large sized trees, which in turn, would result in promoting patches towards Old Forest characteristics.

This treatment would result in no immediate change in Average Patch Size (APS) for OFSS or OFMS within Moist Forest, which would both remain within DRV. However, both of these Old Forest structures would be maintained or promoted by treatment that benefits or promotes medium and large trees, which would have an unknown effect on APS. The changes for APS for most of the rest of the structures would be fairly modest. The exception was SEOC, which would have anAPS increase from 21 to 28%, which would leave this metric below DRV. The PL changes for SECC would have no change, leaving this metric within DRV. The APS for SI would increase by 2 acres from 27, but would remain below HRV. APS

would decrease for both UR and YFMS; going from 39 to 37 and 19 to 18 percent respectively. This would bring the APS for UR further below DRV, while that of YFMS would remain within DRV.

Overall, combining the effects of 4,594 acres of planned treatment, which is 18 percent of the Libby landscape, the effects would be beneficial and short-term with minor intensity on the Amount and Arrangement of Dry and Moist Forest Structures Size for the various structure types within the Buttermilk landscape.

Resource Indicator:*Forest patches with large and medium size trees.*

Under both Alternatives 2and 3, approximately 3,306 acres (575 acres of overstory treatment) out of the 17,898 acres with large or medium trees would be treated in the Buttermilk Creek landscape and another 3,080 acres (889 acres of overstory treatment) out of the 8,463 acres with large and medium trees would be treated in the Libby Creek landscape. These treatments would reduce tree stress from inter-tree competition; decrease vulnerability to defoliators and dwarf mistletoe; and increase fire resiliency within treated stands. This would result in the increased potential for survival of large and residual medium trees within the treated acres as well as increase the growth rate of remaining trees that could eventually result in promoting trees into larger size classes and stands into Old Forest Structure characteristics (see Figure 7). Overstory treatments, together with understory treatments are the most effective and enduring because stocking levels of overstory trees would be reduced and more dwarf mistletoe infected trees would be removed, which decreases dwarf mistletoe infection rates of the remaining trees. The increased growth and corresponding increased health due to overstory/understory treatments would have beneficial, long-term, minor effects in both Buttermilk and Libby landscapes. The effectiveness of stand-alone fuels treatments would have shorter duration and would result in beneficial, short-term, minor effects for both landscapes.

No large trees would be harvested. Some of the medium sized trees would be harvested during overstory thinning and sanitizing, but on the most part, the vast majority of these trees were identified to be retained. It is possible that heavily diseased patches (VRR and DFDMT treatments) or patches with barely enough medium trees to qualify for this patch attribute, may not qualify as patches with medium sized trees after harvest treatments, but the resulting percent of the landscape with medium sized trees would continue to be above DRV for Buttermilk and within DRV for Libby landscapes.

Although there appears to be a need and opportunity to reduce the overabundance of stands with Medium sized trees within the Buttermilk landscape, the actual options to do this in the short term are somewhat limited. The only logical way to do this would be to move UR or YFMS structure to SI structure and SI is already above DRV in the dry forest. The amount of SI in moist forest is on the low end of the DRV, but most of the moist forest patches with Medium sized trees are in the Sawtooth Wilderness and many more potential treatment patches are in areas with no or limited road access. The result is that no patches would be intentionally moved from “Medium” sized trees to “Small”sized trees. However, over time, many of the treated patches would promote into “Large” or “Medium and Large” tree categories.

The expected affects to untreated patches with Medium sized trees would be the same as shownfor the No Action alternative.

Resource Indicator: Western spruce budworm vulnerability compared to the desired range of variability.

Under Alternatives 2 and 3 a combination of overstory and understory thinning treatments would result in changes and maintenance of western spruce budworm vulnerability risk ratings in the project area. For the most part, overstory thinning treatmentscombined with understory fuelsreduction treatments would have the greatest potential to change vulnerability risk ratings, whereas standalone understory thinning treatments would be more likely to maintain existing vulnerability risk ratings. Overstory thinning treatments would reduce western spruce budworm vulnerability by reducing the density of susceptible host trees 7 to 9 inches dbh and larger in the overstory and understory canopy layers, increase the proportion of residual tree stocking with non-host species including ponderosa pine, and effectively reduce the number of canopy layers in treated areas. The Variable Retention Regeneration treatments would reduce host composition and replace it with ponderosa pine seedlings. Understory thinning treatments would reduce vulnerability of defoliation only in the understory canopy layer by reducing the density of susceptible host trees 8 inches dbh and smaller and would reduce the number of canopy layers where the majority of understory trees are in this size range. Residual Douglas-firs in treated areas would benefit from reduced levels of inter-tree competition for sunlight, water, and soil nutrients which would improve their vigor and ability to withstand and recover from western spruce budworm defoliation should it occur. Treatment effects on vulnerability ratings would be expected to last for approximately 30 years at which time sufficient levels of vulnerable understory trees would become established to diminish treatment effectiveness. Details of post-treatment western spruce budworm vulnerability risk ratings are provided in Figure 7.

Buttermilk Creek Landscape

In the Buttermilk Creek Landscape, 655 acres of overstory thinning treatments followed by understory thinning treatments and 3,138 acres of standalone understory thinning treatments would be applied. Following treatment the Percentage of the Landscape (PL) with low risk of defoliation would increase by 1% and move toward attainment of the DRV. The PL for moderate risk would increase by 4% and remain within the DRV. The PL for high risk would decrease by 4% and move toward attainment of the DRV. Overall, post-treatment conditions would be a combination of beneficial, long term, minor effects on western spruce budworm vulnerability classes.

Libby Creek Landscape

In the Libby Creek Landscape, 1,363 acres of overstory thinning treatments followed by understory thinning treatments and 4,215 acres of standalone understory thinning treatments would be applied. Following treatment the Percentage of the Landscape (PL) with low risk of defoliation would increase by 1% and move away from attainment of the DRV. The PL for moderate risk would increase by 6% and remain within the DRV. The PL for high risk would decrease by 7% and move toward attainment of the DRV. Overall, post-treatment conditions would be a combination of beneficial, long term, minor effects for the moderate and high vulnerability classes and an adverse, long term, negligible effect for the low

western spruce budworm vulnerability class. Although increasing low vulnerability when it is already above DRV may be adverse for landscape vegetation patterns, it would benefit the health of medium and large Douglas-fir trees and all of the other vegetation attributes that depend on that species and size of trees.

Resource Indicator: Forest vegetation vulnerable Douglas-fir bark beetles.

Under Alternatives 2 and 3, there would be overstory and understory treatments totaling 137 acres within patches with Moderate and 513 acresof treatment with Highvulnerability to Douglas-fir bark beetles(DFBB) within the Buttermilk landscape, representing 6% of the moderate and high vulnerability acres. Within the Libby landscape there would be overstory and understory treatments totaling 971 acres within patches with moderate vulnerability and 404 acresof treatment with highvulnerability to DFBB, which would be 10 percent of the treated. These treatments would be effective in reducing host abundance, number of canopy layers, stand density in the treated stands. By reducing all of these factors in vulnerability to DFBB, individual tree vigor should improve, allowing these trees to produce pitch and defend themselves from beetle attacks. The thinning of the overstory and the reduction in the abundance of Douglas-fir would be effective for the next 20-40 years, while the understory would return within 20 years. This would result in beneficial, long-term, negligible effects for both landscapes.The Variable Retention Regeneration with planting ponderosa pine after harvest treatments would decrease host species and increase non-host specie composition on 80 acres. This effect would last indefinitely.Also, by simultaneously reducing risk for Western spruce budworm and crown fire there is a synergistic effect of reducing the potential for a disturbance that could trigger DFBB outbreaks.

Simultaneously with these more complete treatments, the vulnerability to DFBB would be moderated by understory treatments in an additional 2,845 acres of moderate and high Vulnerability patches in the Buttermilk landscape. Within the Libby landscape, 2,477 acres of the Moderate and High vulnerability patches would receive understory treatments. The duration of these treatments would be more ephemeral than that of overstory treatments and some of the vulnerability factors would only partially be treated. These treatments, which represent 27% and 24% of the moderate and high vulnerability patches in the Buttermilk and Libby landscapes respectively. These treatments alone would provide beneficial, short-term, minor impacts for both landscapes, but together with overstory treatments, would result in beneficial, short-term, moderate effects for both landscapes. Also, by simultaneously reducing risk for Western spruce budworm and crown fire, there is a synergistic effect of reducing the potential for a disturbance that could trigger DFBB outbreaks.

Resource Indicator: Forest vegetation vulnerable to dwarf mistletoe infection

Under Alternatives2 and 3, 633 of the 6,349 acres of stands identified as vulnerable to Douglas-fir dwarf mistletoe infection within the Buttermilk landscape and 1,305 of 10,961 acres of vulnerable stands within the Libby Creek landscape would receive both overstory and understory treatments. Overstory, together with follow-up ladder fuel reduction treatments, would remove most DMT infected trees less than 18 inches DBH from those patches. Some DMT infected trees between 18 and 24 inches DBH may also be harvested but the need to do this would be weighed against their contribution to elements of Old Foreststructure. Overstory treatments would reduce the density of susceptible host trees and the

number of canopy layers, increase the proportion of residual tree stocking with non-host species including ponderosa pine, and isolate residual infected trees in groups or individual trees to reduce vulnerability to infection in the treated stands. The planned Variable Retention Regeneration harvest treatment areas would be planted in ponderosa pine, post-harvest. This would result in reducing host specie and increasing no-host specie composition. These treatments would also restore elements of historic tree species composition and dwarf mistletoe distribution in treated areas.These treatments would have beneficial,long-term, negligible impact in the Buttermilk landscape and beneficial, long-term minor impact on the Libby landscape.

The 2,718and 3,190 acres of standalone non-harvest thinning treatments planned for the Buttermilk and Libby landscapes, respectively, would result in removal of susceptible understory host trees and a reduction of DFDM in the remaining smaller trees. These treatments would also reduce the number of canopy layers in the treated stands. Where there are no infections in the overstory, these stands would have the potential to progress to target stand structures. These treatments would have beneficial, short term, minor impact to both of the landscapes.

In currently infected stands, the effects of stand thinning, as well as the removal of DFDM infected trees should result in a reduction of competition for remaining trees resulting in increased vigor, overall increase of average diameter growth within treated stands, and an increased potential to survive fires.This would result in increased potential and rate for treated stands to attain or retain desired structure classes. The effects of this treatment should result in a 20-40 year improvement in DFDM rating for the totally sanitized stands.

Infection intensity of any DFDM infected trees that remain would increase by responding to increased sunlight reaching infected branches and by having unimpeded dispersal(Graham 1961). Where infected trees remain in the overstory, future sanitizing and thinning treatments of understory trees would be needed or DFDM would spread to this new cohort of host species and stand DFDM ratings and landscape vulnerability to DFDM would return to current levels.

In stands that are currently free of DFDM, overstory treatment would result in decreased vulnerability by reducing the density of Douglas-fir trees, reducing the overall stocking and reducing number of tree canopies. Reduced vulnerability to DFDM would maintain the potential for those stands to continue to develop towards meeting resource objectives.

The improvements in diameter growth and fire resilience would last until a new understory establishes, which would be 15 to 20 years, but this benefit could be extended with future sanitation of the understory or, to a lesser degree, by underburning alone at year 15 after this project is completed.

Untreated vulnerable stands would have the same effects as that shown for the No Action Alternative.

Overall, the vegetation treatments in Alternatives 2 and 3 would result in a beneficial, short term, minor effect on the Buttermilk landscape and a beneficial, long-term, minor effect on the Libby landscape.

Figure 7. Resource Indicators and Measures Common to Alternatives 2 and 3

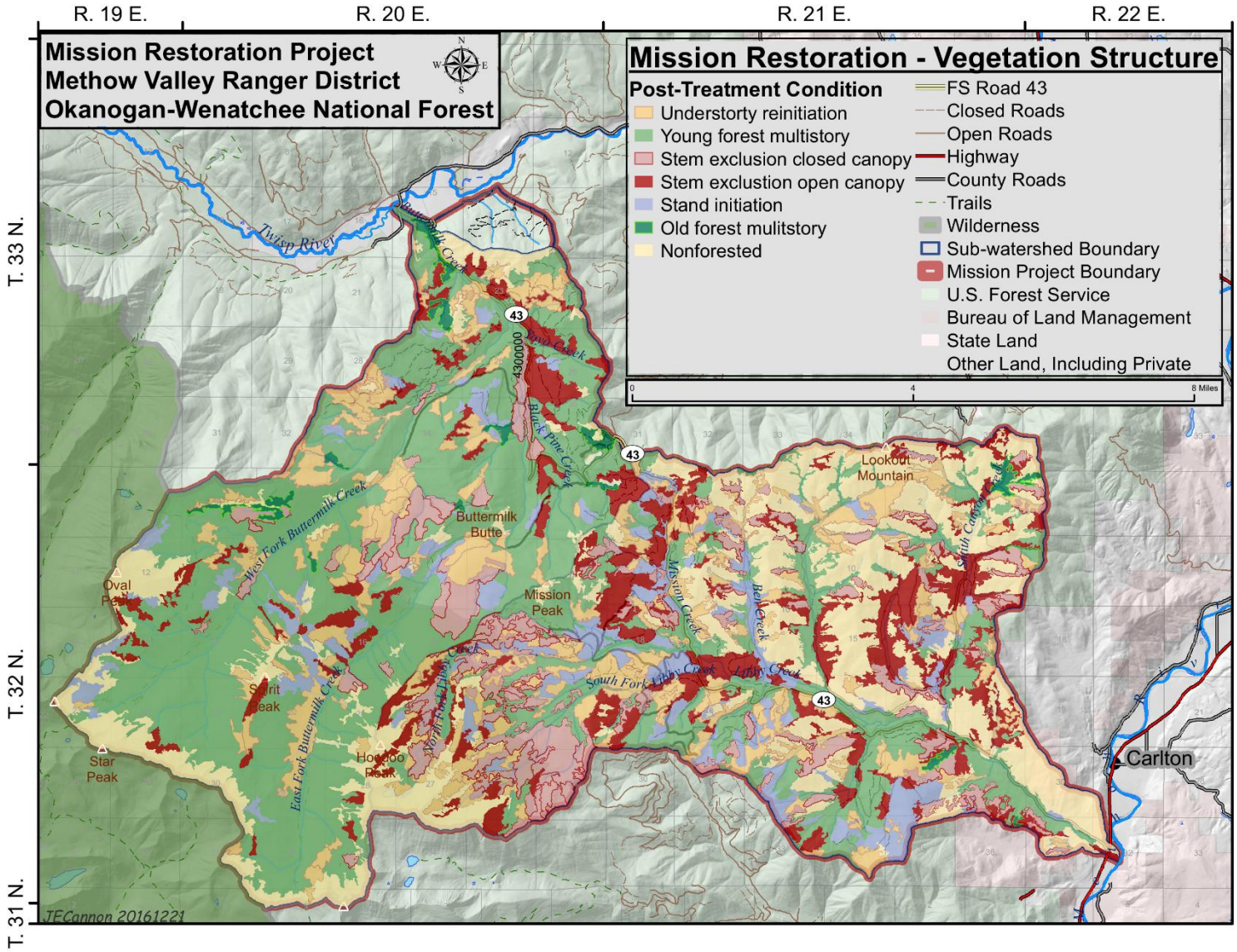
Resource Element	Resource Indicator	Measure	Effects of Alternatives 2 and 3		
Forest Vegetation Composition and Structure.	The amount and arrangement of dry and moist forest structures compared to the desired range of variability.	Percentage of the Buttermilk and Libby Creek landscapes occupied by dry and moist forest structures.	**Dry Forest**		
			Structure	**Buttermilk**	**Libby**
			OFMS	1.4%; No Immediate Change Remains Within DRV of 0-2.3%	0.4%; No Immediate Change Remains Within DRV of 0-2.3%
			OFSS	0%; No Immediate Change Remains Within DRV of 0-2.6%	0%; No Immediate Change Remains Within DRV of 0-0.9%
			SECC	0.6%; Decrease: 0.8% Remains **Above** DRV of 0-0.3%	6.5%; Decrease: 1.5% Remains **Above** DRV of 0-0.8%
			SEOC	4.5%; Increase: 2.4% Now within DRV of 3.5-6.6%	11.9%; Increase: 5.8% Remains Within DRV of 3.5-17.4%
			SI	1.3%; Decrease:0.1% Remains **Above** DRV of 0-0.5%	6.4%; Increase: 1.2% Remains Within DRV of 0-10%
			UR	3.3%; Increase: 0.1% Further **Above** DRV of 0-2.3%	10.2%; Decrease: 0.8% Remains **Above** DRV of 0.2-9.9%
			YFMS	17.1%; Decrease: 1.5% Remains **Above** DRV of 0-1.7%	11.0%; Decrease: 3.0% Remains **Above** DRV of 0-9.1%
			Moist Forest		
			Structure	**Buttermilk**	**Libby**
			OFMS	0.5%; No Immediate Change Remains Within DRV of 0-5.6%	0.5%; No Immediate Change Remains Within DRV of 0-11.2%
		.	**OFSS**	0%; No Immediate Change Remains Within DRV of 0-5.3%	0%; No Immediate Change Remains Within DRV of 0-3.0%
			SECC	1.4%; Negligible Change Remains Within DRV of 0.4-5.6%	0.8%; No Change Remains Within DRV of 0-5%

Resource Element	Resource Indicator	Measure	Effects of Alternatives 2 and 3		
			SEOC	0.4%; Increase: 0.2% Remains **Below** DRV of 2.5-12.3%	0.7%; Increase: 0.3% Remains **Below** DRV of 2.5-12.3%
			SI	0.3%; No Change Remains **Below** DRV of 0.9-8.9%	1.3%; Decrease: 0.1% Remains Within DRV of 0.9-9.9%
			UR	1.3%; Negligible Change Remains Within DRV of 1-10.3%	1.1%; Decrease: 0.1% Remains Within DRV of 1-18.4%
			YFMS	3.9%; Decrease: 0.2% Remains Within DRV of 0.7-8.4%	5.9%; Decrease: 0.1% Remains Within DRV of 0-18.1%
		Average patch size of dry and moist forest structures in the Buttermilk and Libby landscapes. (acres) .	**Dry Forest**		
			Structure	**Buttermilk**	**Libby**
			OFMS	0.5%; No Immediate Change Remains Within DRV of 0-5.6%	0.5%; No Immediate Change Remains Within DRV of 0-11.2%
			OFSS	0%; No Immediate Change Remains Within DRV of 0-5.3%	0%; No Immediate Change Remains Within DRV of 0-3.0%
			SECC	1.4%; Negligible Change Remains Within DRV of 0.4-5.6%	0.8%; No Change Remains Within DRV of 0-5%
			SEOC	0.4%; Increase: 0.2% Remains **Below** DRV of 2.5-12.3%	0.7%; Increase: 0.3% Remains **Below** DRV of 2.5-12.3%
			SI	0.3%; No Change Remains **Below** DRV of 0.9-8.9%	1.3%; Decrease: 0.1% Remains Within DRV of 0.9-9.9%
			UR	1.3%; Negligible Change Remains Within DRV of 1-10.3%	1.1%; Decrease: 0.1% Remains Within DRV of 1-18.4%
			YFMS	3.9%; Decrease: 0.2% Remains Within DRV of 0.7-8.4%	5.9%; Decrease: 0.1% Remains Within DRV of 0-18.1%
			Moist Forest		
			Structure	**Buttermilk**	**Libby**
			OFMS	57 ac.; No Immediate Change Remains Within DRV of 0-312 ac	27 ac.; No Immediate Change Remains Within DRV of 0-348 ac

Resource Element	Resource Indicator	Measure	Effects of Alternatives 2 and 3		
			OFSS	0 ac.; No Immediate Change Remains Within DRV of 0-255 ac	0 ac.; No Immediate Change Remains Within DRV of 0-213 ac
			SECC	107 ac.; Increase: 39 ac Remains Within DRV of 42-927 ac	26 ac.; No Change Remains Within DRV of 0-174 ac
			SEOC	52 ac.; Increase: 15 ac Now Within DRV of 50-249 ac	28 ac.; Increase: 7 ac Remains **Below** DRV of 50-249 ac
			SI	31 ac.; No Change Remains **Below** DRV of 32-177 ac	29 ac.; Increase: 2 ac Remains **Below** DRV of 32-177 ac
			UR	37 ac.; Decrease: 2 ac Further **Below** DRV of 68-246 ac	18 ac.; Decrease: 1 ac Further **Below** DRV of 68-383 ac
			YFMS	66 ac.; Decrease: 8 ac Remains Within DRV of 46-363 ac	85 ac.; Increase: 3 ac Remains Within DRV of 0-440 ac
	Forest patches with, large and medium size trees.	Acres treated in the Buttermilk and Libby landscapes to maintain and restore large trees in patches with medium, large, or large and medium size trees.	Buttermilk. Medium Trees – 284 acres treated of 14,867 ac available Large Trees - 182 acres treated of 2,391 ac available Large and Medium – 110 acres treated of 640 ac available		Libby Medium Trees – 2,958 acres treated of 8,142 acres available Large Trees – 122 acres treated of 321 acres available Large and Medium – 0 acres available
Resilience to biotic natural disturbances.	Western spruce budworm vulnerability compared to the desired	Percentage of the Buttermilk and Libby Creek landscapes with			
			Risk	**Buttermilk**	**Libby**
			Low	16%; Increase: 1% Remains **Below** DRV of 22-28%	33%; Increase: 1% Remains **Above** DRV of 12-28%

Resource Element	Resource Indicator	Measure	Effects of Alternatives 2 and 3		
	range of variability.	high, moderate, and low risk.	Moderate	19%; Increase: 4% Remains Within DRV of 13-33%	17%; Increase: 6% Remains Within DRV of 8-27%
			High	65%; Decrease: 4% Remains **Above** DRV of 31-52%	50%; Decrease: 7% Remains Within DRV of 29-74%
	Forest vegetation vulnerable to Douglas-fir bark beetles.	Acres of treatment in the Buttermilk and Libby landscapes with high or moderate risk.	Moderate - 1,111 acres treated (137 overstory treatment) of 6,061 acres available High - 2,384 acres treated (513 overstory treatment) of 4,463 acres available		Moderate - 2,615 acres treated (971 overstory treatment) of 11,820 acres available High - 1,237 acres treated (404 overstory treatment) of 2,532 acres available
	Forest vegetation vulnerable to dwarf mistletoe infection.	Acres treated in the Buttermilk and Libby Creek landscapes to reduce vulnerability.	Buttermilk = 3,351 (633 overstory treatment) of 6,349 ac. Available		Libby = 4,495 (1.305 overstory treatment) of 10,961 ac. Available

Figure 8. Post-project vegetation structure for Alternatives 2 and 3.



Cumulative Effects

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

There are no concurrent or reasonably foreseeable activities within the Mission Forest and Fuels Project area that would affect vegetation.

Compliance with LRMP and Other Relevant Laws, Regulations, Policies and Plans

Alternative 1 is in compliance with all LRMP, laws, regulations, policies and plans.

Both action alternatives meet Okanogan NF LRMP Forest-wide Standards and Guidelines (FW S&G)in that;

- FW S&G 5-1: No harvest would take place in mixed conifer old growth stands
- FW S&G 20-14: Commercial thinning would thin from below (generally leave the largest trees)
- FW S&G 20-15: Intermediate thinning would have a beneficial effect regarding the vulnerability to insects and disease.
- FW S&G 20-28: The Landscapes would be managed to maintain or promote historic composition of tree species.
- FW S&G 20-34: Pre-commercial thinning (understory treatments) would take place in overstocked stands.
- FW S&G 20-35: Pre-commercial thinning (understory treatments) would reduce and minimize the spread of disease or the favorable conditions for injurious forest insects
- FW S&G 20-41: No openings over 40 acres in size would be created.

Both vegetation management in both alternatives would meet Okanogan NF LRMP management direction for Management Area 5 in that stands would be managed to control insects and disease problems and vegetation management activities would meet visual quality objectives for roaded natural recreation by managing the foreground of FSR 4300,retaining natural form, line, color, texture, and pattern on the landscape. Direction for Management Area 14 would be met in that the proposed timber harvest is designed to perpetuate the Desired Range of Variability for vegetation. Direction for Management Area 25 would be met in that the landscape would be intensively managed using both even aged and unevenaged silvicultural practices, while protecting the land for other resources and stands with high levels of dwarf mistletoe would be treated.

Neither action alternative includes vegetation management treatment within Congressionally Reserved areas (Wilderness) or inventoried roadless areas.

Both action alternatives would meet Northwest Forest Plan Objectives for Matrixin that 15 percent of the units identified for Variable Retention Regeneration treatment would be left through the next rotation and would be comprised of forest patches from 0.5-2.5 acres in size.

Both action alternatives would meet Northwest Forest Plan Objectives for Riparian Reserves in that the proposed commercial and noncommercial stocking reduction of conifers would result in maintaining or

promoting deciduous shrub and tree species as well as decreasing fuel levels that would make Riparian Reserves more fire resilient.

Both action alternatives would meet Northwest Forest Plan Objectives for Late Successional Reserves in that planned noncommercial treatments would reduce conifer encroachment in aspen stands and open the canopy and reduce potential for crown fire and competition between trees, which would reduce the risk of habitat loss of the late/old habitat.

Required Monitoring

After all harvest and post-harvest activities are complete, openings over two acres in size created by proposed activities in the two action will be planted and then monitored for regeneration success. The minimum acceptable stocking level for reforestation certification is 100 vigorous conifer seedlings per acre.

Summary

There is no difference between the two action alternatives. Under both alternatives Two and Three, the planned vegetation management treatments would move towards or maintain the Desired Range of Variability for Forest Vegetation Composition and Structure and vulnerability to western spruce budworm in both the Buttermilk and Libby landscapes. Both alternatives would considerably reduce the acres of high and moderate vulnerability to Douglas-fir beetles and treat acres vulnerable to Douglas-fir dwarf mistletoe. The planned treatments would maintain or promote medium and/or large trees on nearly 14% of the combined landscapes.

Degree to Which the Purpose and Need for Action is Met

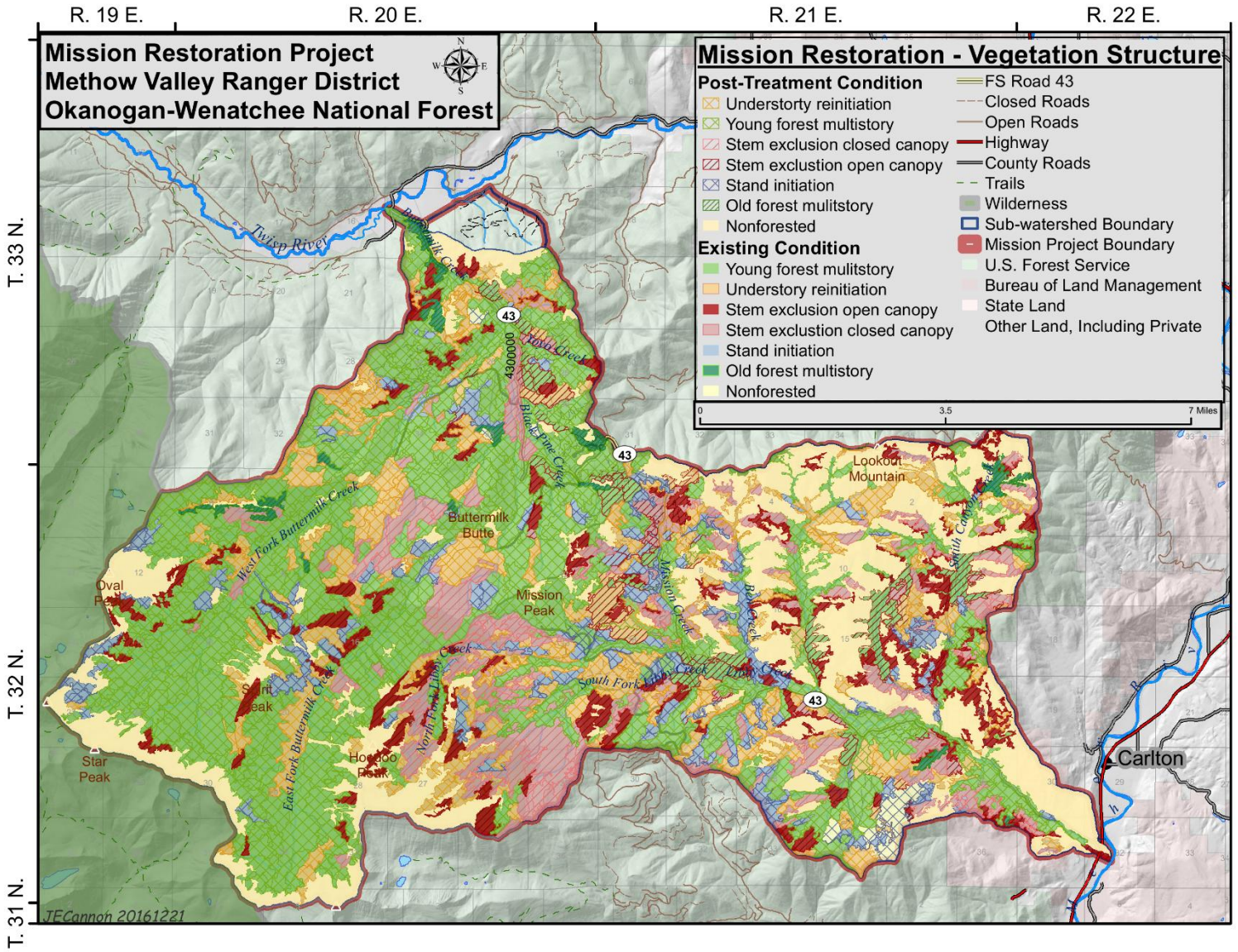
Alternative 1 does nothing to improve vegetation composition and structure within the project area, but in the short term most of the conditions that are currently within the Desired Range of Variability (DRV) would remain within DRV.Alternative 1 would not reduce vulnerabilities for insect and disease nor would it promote or maintain any medium and large trees on the landscapes. Alternatives 2 and 3 would result in many more categories of vegetation and structure heading towards DRV or actively maintains categories within DRV. Alternatives 2 and 3 do much more towards reducing vulnerabilities to insects and disease and thus promoting and maintaining medium and large trees within the two landscapes.

Figure 9. Summary comparison of how the alternatives address the Purpose and Need

Purpose and Need	Indicator	Measure	Alt 1	Alt 2 and 3
P & N #3 – Vegetation Composition and Structure	The amount and arrangement of dry and moist forest structures compared to	Percent Landscape	17 out of 28 Categories Within DRV	25 out of 28 Categories within or moving toward DRV

	the desired range of variability.	Average Patch Size	18 out of 28 Categories Beneficial within DRV	28 out of 28 Categories Beneficial within or moving toward DRV
	Forest patches with large and medium size trees.	Acres treated	0	3,656
	Western spruce budworm vulnerability compared to the desired range of variability.	Percent Landscape In Low, Medium and High Vulnerability Levels	3 out of 6 categories within DRV	6 out of 6 categories within or moving toward DRV
	Forest vegetation vulnerable to Douglas-fir bark beetles.	Acres of treatment in the Buttermilk and Libby landscapes with high or moderate risk.	0	7,347
	Forest vegetation vulnerable to dwarf mistletoe infection.	Acres treated in the Buttermilk and Libby Creek landscapes to reduce vulnerability.	0	7,846

Figure 10. Existing condition and post-project treatment area for the project area.



Acronyms

APS – Average Patch Size

BE - Biophysical Environment

DBH - Diameter at Breast Height

DFB – Douglas-fir Beetle

DFDM–Douglas-fir Dwarf Misteltoe

DRV – Desired Range of Variability

EMDS - Ecosystem Management Decision Support

ESR - Ecological Subregion

FRV – Future Range of Variability

GIS - Geographic Information Systems

HRV - Historical Range of Variability

IDT – Interdisciplinary Team

LFR - Ladder Fuel Reduction

LOS - Late and Old Successional structure

LOSM - Late and Old Successional, multistory structure

LOSS - Late and Old Successional, single story structure

LRMP - Land Resource Management Plan

LS - Late Successional structure

OG –Okanogan NF LRMP Old Growth

ONF - Okanogan National Forest

PD - Patch Density

PCT - Pre-commercial Thin

PL - Percent Landscape

SECC - Stem Exclusion Closed Canopy

SEOC - Stem Exclusion Open Canopy

SI - Stand Initiation

VRR – Variable Retention Regeneration

WUI - Wildland Urban Interface

YFMS - Young Forest Multi Story

Glossary

Broom: A cluster of branches, radiating from a single point that results from damage in a tree from agents such as mistletoe.

Cambium: Layer of living cells between the wood and the innermost bark of a tree. Each growing season the cambium adds a new layer of cells (by cell division) on the wood already formed, as well as a layer of inner bark on the cambium's outer face.

Canopy: A layer of foliage in a forest stand. Most often refers to the uppermost layer of foliage, but can be used to describe lower layers within a multistoried stand.

Canopy Closure: The degree to which the crowns of trees are nearing general contact with one another. Generally measured as the percent of the ground surface that would be covered by a vertical projection of foliage in the crown of trees.

Cohort: Trees within a cohort share a common disturbance history; they are those initiated or released after a disturbance (natural or artificial). Tree ages within a cohort may span several decades.

Commercial Thin: A silviculture treatment that "thins" out an overstocked stand by removing trees that are large enough to be sold as saw timber. It is carried out to improve the health and growth rate of the remaining crop trees.

Composition: The abundance, or relative abundance of components, such as water, nutrients, and species, that makes up the ecosystem.

Connectivity: 1). The arrangement of habitats that allows organisms and ecological processes to move across the landscape. 2). Patches of similar habitats that are either close together or linked by corridors of appropriate vegetation. The opposite of fragmentation.

Crown: the bole, branches, limbs and foliage of a tree between the lowest limb with foliage, live or dead, and the top of the tree.

Crown Fire: The movement of fire through the crowns or tops of trees or shrubs more or less independently of the surface fire. A fire is said to be crowning when the flames get up into the tops of trees and spreads.

DBH or dbh: Diameter Breast Height; 4.5 feet above ground level.

Dead Fuels: Fuels with no living tissue in which moisture content is governed almost entirely by atmospheric moisture (relative humidity and precipitation), dry-bulb temperature, and solar radiation.

Defoliation: the loss of foliage by a tree, usually as a result of feeding insect larvae.

Disturbance: A significant change in structure and/or composition caused by natural events such as fire, wind, flood, and human caused events.

Diversity: The variety and relative extent of ecosystem types, including their composition, structure, and process within all or a part of an area.

Dwarf Mistletoe: parasitic plants that parasitize conifers, often redirecting tree nutrients and growth to parasitized portions of the tree.

Fragmentation: As related to forest management, fragmentation is a process that results in habitat conversion, habitat discontinuity, and eventually the isolation or insularization of the original habitat. The process of fragmentation occurs across a range of landscape patterns. At one extreme, it is represented by small disturbance patches, which disrupt the continuity of habitat. At the other extreme, widespread habitat conversion causes isolation of the remnant original habitat into patches.

Function: The process through which composition and function interact, including predation, decomposition, and disturbances, such as fire and floods.

Historic Range of Variability (HRV): The bounded behavior of ecosystems prior to the dramatic changes in state factors that accompanied the settlement of North America, beginning with the discovery of the "New World".

Large Sized Trees: Those trees that are >25 inches, diameter breast height (dbh).

Medium Sized Trees: a tree 16-25 inches, dbh

Mesic: Refers to moist to moderately moist soil conditions. Under mesic conditions, soil moisture is predictably adequate for plant growth during the growing season.

Old Forest – Patches characterized by a predominance of Large Sized Trees (>30 crown cover of trees greater than 25 inches dbh) as defined by the EMDS process.

Patch: an area (minimum of 10 acres) consisting of one or more contiguous polygonswithin a landscape with like vegetation attributes.

Pole Size Trees: A tree 5-9" dbh.

Pre-commercial Thin – reducing the number of live tree stems to allow increased growth and vigor for the remaining trees, where the average size of targeted trees for removal is not of sufficient value to pay the cost of logging and hauling.

Prescription (silviculture): either a general term used to describe a set of vegetation management activities (i.e. irregular shelterwood harvest or aspen release) ; or a site specific document, prepared by a certified silviculturist, where the stand is described; the specific management and silvicultural objectives are outlined; guidelines for identifying trees to be harvested are provided; and post-sale activities are listed.

Regeneration: The establishment of new seedlings in response to timber management or disturbance**.**

Resilience: The capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks.

Sapling: Tree less than 5 inches dbh

Seral: A biotic community that is a developmental, transitory stage in an ecological succession.

Seral Species: A species associated with a stage (sere) in the development of a biotic community.

Site Preparation: activities applied to a stand to enhance site establishment of tree species that include but are not limited to felling small trees, underburning and herbicide treatment that removes vegetative competition and/or exposes mineral soil to facilitate natural seeding or planting

Small Sized Trees – a tree 10-15 inch dbh

Snag:A standing dead tree or part of a dead tree from which at least the smaller branches have fallen.

Stand: A stand is a spatially continuous group of trees and associated vegetation having similar structures and growing under similar soil and climatic conditions. (Oliver & Larson, 1996)

Stand D**evelopment:** is the part of stand dynamics concerned with changes in stand structure over time. (Oliver, 1996)

Stand Initiation: Growing space is reoccupied following a stand replacing disturbance. *Description:* One canopy stratum (may be broken or continuous). One cohort of seedlings or saplings; grass, forbs, and shrubs may be present. **Invalid source specified.**

Stem Exclusion Closed Canopy: New individuals are excluded through light or underground competition. *Description:* Continuous closed canopy, usually one cohort; poles, small or medium trees present. Suppressed trees, grasses, shrubs, and forbs may be absent in some cover types. **Invalid source specified.**

Stem Exclusion Open Canopy: Underground competition limits establishment of new individuals. *Description:* One broken canopy stratum which included poles or small trees; grasses, shrubs, or forbs may also be present. **Invalid source specified.**

Stocking: A description of the number of trees, basal area, or volume per acre in a forest stand compared with a desired level for balanced health and growth. Most often used in comparative expressions, such as well-stocked, poorly stocked, or overstocked

Structural Class or Stand Structure: A classification of stand structures based on stand development that accounted for disturbance regimes typical of the inland northwest. Stratifying a landscape into these process-based structure classes allows subsequent analysis of landscape pattern and ecological processes, i.e. disturbance and succession.

Structure: The physical arrangement in space of water, nutrients, and species, that makes up the ecosystem.

Successional Stage: a stage or recognizable condition of a plant community that occurs during its development from bare ground to climax.

Sustainability: Meeting needs of the present generation without compromising the ability of future generations to meet their needs. Sustainability is composed of desirable social, economic, and ecological conditions or trends interacting at varying spatial and temporal scales, embodying the principles of multiple-use and sustained yield.

Understory Re-initiation: Initiation of new cohort as older cohort occupies less than full growing space. *Description:* Broken overstory canopy with formation of understory stratum; two or more cohorts. Overstory may be poles or larger trees; understory is seedling, saplings, grasses, forbs, or shrubs. **Invalid source specified.**

Variable Retention: is a relatively new silvicultural system that retains forest structural elements for at least one rotation (when the stand is once again regenerated) in order to preserve environmental values associated with structurally complex forests (Franklin. 1997).

Windthrow: when all or large portions of trees are blown down by wind, often in conjunction with rain, snow or icing events.

Young Forest Multistory: Two or more cohorts present through establishment after periodic disturbances including harvest events. *Description:* Multi-aged (multi-cohort) stand with assortment of tree sizes and canopy strata present but very large trees absent. Grasses, forbs, and shrubs may be present. **Invalid source specified.**

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United States
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Agriculture

Forest Service

Pacific
Northwest
Region

Blue Mountains Pest Management Zone

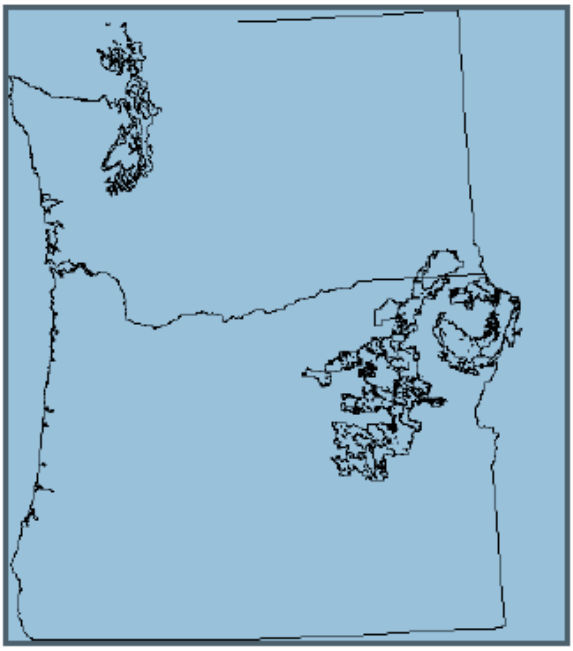
Wallowa-Whitman National Forest

BMZ-97-2
March, 1997

BMPMZ Management Guide

Management of Douglas-fir Infected with Dwarf Mistletoe in the Blue Mountains of Northeastern Oregon and Southeastern Washington

Craig L. Schmitt
Zone Pathologist



Caring for the Land and Serving People

Forest Science, Vol. 36, No. 4, pp. 955–969

Intensification of Dwarf Mistletoe on Southwestern Douglas-fir

B. W. GEILS
R. L. MATHIASEN

ABSTRACT. From a sample of 445 Douglas-fir trees infected with dwarf mistletoe (*Arceuthobium douglasii*), three models for predicting mistletoe intensification are developed. Two models relate the mean rate of intensification since the tree became infected to initial and current tree conditions; the third one describes the proportion of trees that increased by 0, 1, 2, or more classes of dwarf mistletoe infection (DMR) in the past 10 years. The models suggest that the rate of intensification is most rapid (2 DMR classes per decade) for severely infected trees of small diameter and slowest (0.5 DMR classes per decade) for lightly infected trees of large diameter. Intensification within a tree increases with the abundance of mistletoe in nearby, larger trees and with stand basal area. No other significant relations were found between rates of intensification and site or stand factors such as habitat type, site productivity, or stand composition. A comparison of mistletoe ratings for standing trees and ratings for carefully examined felled trees indicates that trees can be correctly rated by standard procedures about 75% of the time. FOR. SCI. 36(4):955–969.

ADDITIONAL KEY WORDS. *Pseudotsuga menziesii*, *Arceuthobium douglasii*, disease rating, models.

DWARF MISTLETOES (*Arceuthobium* spp.) are the most serious disease agents in southwestern mixed conifer forests (Jones 1974), and Douglas-fir dwarf mistletoe (*A. douglasii* Engelm.) is the most damaging and prevalent species (Hawksworth and Wiens 1972). Throughout the interior West, this parasite causes increased mortality of Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco) and significantly reduces the growth of severely infected trees (Hawksworth and Lusher 1956, Pierce 1960, Graham 1961, Shea 1963). Mortality of Douglas-fir in severely infested stands of the Southwest is three to four times the average rate in healthy stands, and volume growth of severely infected trees is reduced by 65% (Mathiasen et al. 1990a). This dwarf mistletoe infests about 50% of the mixed conifer stands in Arizona and New Mexico (Andrews and Daniels 1960).

Because Douglas-fir dwarf mistletoe is widespread and extremely damaging, estimates of its effects on tree growth and survival, and predictions of its intensification and spread are necessary for accurate yield projections (Edminster et al. 1990). In a prior study, Mathiasen et al. (1990a) relate the abundance and distribution of dwarf mistletoe to decreased growth and survival of Douglas-fir in mixed conifer stands; in this study, we develop functions to describe the rate of increase of dwarf mistletoe within infected trees.

The increase in abundance and distribution of dwarf mistletoe is described as

Dwarf Mistletoes: Biology, Pathology, and Systematics

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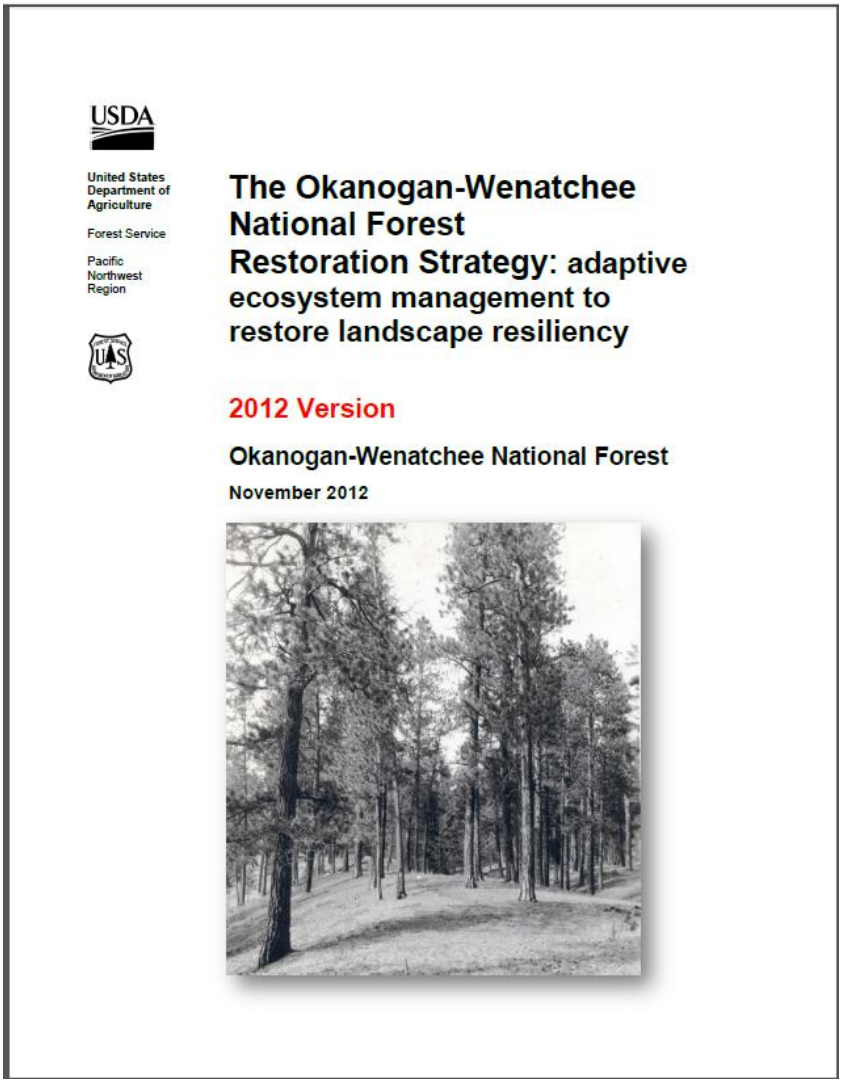

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Forest Service

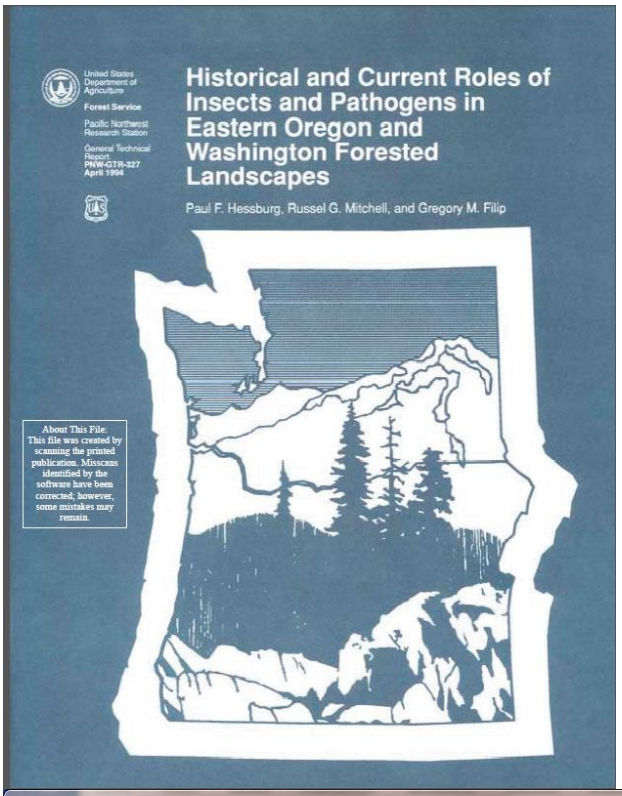
Pacific Northwest Region

The Okanogan-Wenatchee National Forest Restoration Strategy: adaptive ecosystem management to restore landscape resiliency

2012 Version

Okanogan-Wenatchee National Forest

November 2012


United States Department of Agriculture
Forest Service
Pacific Northwest Research Station
General Technical Report PNW-GTR-327 April 1994
Historical and Current Roles of Insects and Pathogens in Eastern Oregon and Washington Forested Landscapes
Paul F. Hessburg, Russel G. Mitchell, and Gregory M. Filip
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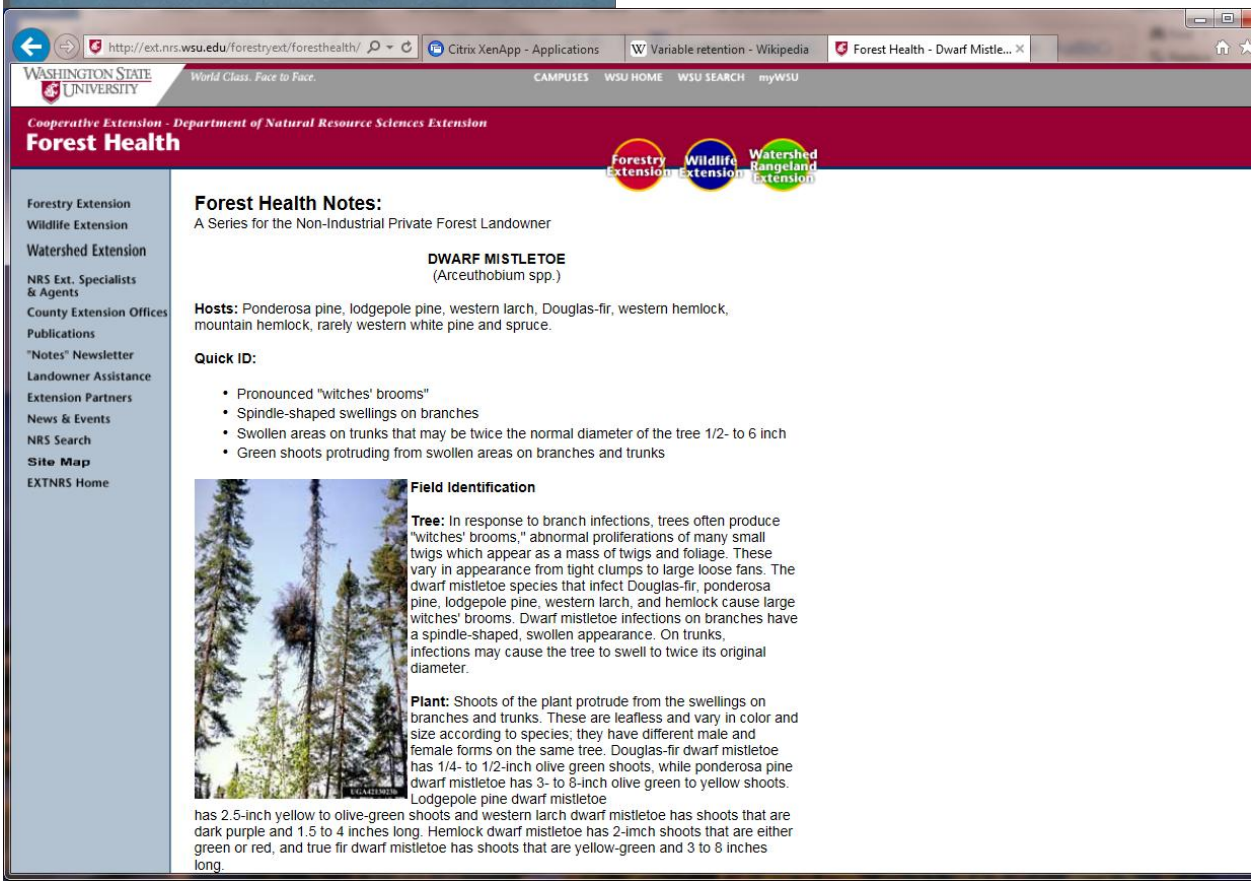
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News & Events
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Forest Health Notes:
A Series for the Non-Industrial Private Forest Landowner
DWARF MISTLETOE
(Arceuthobium spp.)
Hosts: Ponderosa pine, lodgepole pine, western larch, Douglas-fir, western hemlock, mountain hemlock, rarely western white pine and spruce.
Quick ID:
Pronounced "witches' brooms"
Spindle-shaped swellings on branches
Swollen areas on trunks that may be twice the normal diameter of the tree 1/2- to 6 inch
Green shoots protruding from swollen areas on branches and trunks
Field Identification
Tree: In response to branch infections, trees often produce "witches' brooms," abnormal proliferations of many small twigs which appear as a mass of twigs and foliage. These vary in appearance from tight clumps to large loose fans. The dwarf mistletoe species that infect Douglas-fir, ponderosa pine, lodgepole pine, western larch, and hemlock cause large witches' brooms. Dwarf mistletoe infections on branches have a spindle-shaped, swollen appearance. On trunks, infections may cause the tree to swell to twice its original diameter.
Plant: Shoots of the plant protrude from the swellings on branches and trunks. These are leafless and vary in color and size according to species; they have different male and female forms on the same tree. Douglas-fir dwarf mistletoe has 1/4- to 1/2-inch olive green shoots, while ponderosa pine dwarf mistletoe has 3- to 8-inch olive green to yellow shoots. Lodgepole pine dwarf mistletoe has 2.5-inch yellow to olive-green shoots and western larch dwarf mistletoe has shoots that are dark purple and 1.5 to 4 inches long. Hemlock dwarf mistletoe has 2-imch shoots that are either green or red, and true fir dwarf mistletoe has shoots that are yellow-green and 3 to 8 inches long.

Silvicultural Approaches to Western Spruce Budworm Management in the Northern U.S. Rocky Mountains

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Stand susceptibility to western spruce budworm is affected by the interaction of site and stand factors, such as species composition, stand density, height-class structure (tree-height variability), vigor, maturity, site climate, regional climate, and degree of isolation from other susceptible stands. Susceptible stands are primarily shade-tolerant conifers, very dense and of low vigor, multistoried, physiologically mature, and on warm, dry sites characterized by relatively warm, dry regional climate. All factors — except regional and site climate — can be changed silviculturally to reduce susceptibility to budworm. Even-aged management of seral, shade-intolerant species will substantially reduce stand susceptibility; all-aged management is appropriate when nonhost species are featured. Stands can be rated for susceptibility to budworm by using quantitative indexes for important site and stand factors. Silvicultural treatment provides immediate and long-term benefits to treated stands; forest susceptibility will be gradually reduced as more stands are treated. Reducing the habitat of western spruce budworm through silvicultural methods is a good, long-term approach for dealing with budworm in the northern U.S. Rocky Mountains and probably elsewhere in western North America. Silvicultural treatments, however, probably will not be applied extensively in Wilderness or in other lands not designated for timber production. Although our knowledge of budworm has increased substantially during the CANUSA-West Program, much research is needed before we truly understand the interactions between budworm and its environment.

La vulnérabilité d'un peuplement à la tordeuse occidentale de l'épinette dépend de l'interaction de facteurs stationnels et de facteurs liés au peuplement (composition des espèces, densité du peuplement, répartition des classes de hauteur, vigueur, maturité, climats stationnel et régional et degré d'isolement d'autres peuplements vulnérables). Les peuplements vulnérables sont surtout constitués de conifères très denses et peu vigoureux, pluri-étagés et à maturité, qui tolèrent l'ombre et qui occupent des stations chaudes et sèches caractérisées par un climat régional relativement

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Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example

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Abstract

Forest managers need a comprehensive scientific understanding of natural stand development processes when designing silvicultural systems that integrate ecological and economic objectives, including a better appreciation of the nature of disturbance regimes and the biological legacies, such as live trees, snags, and logs, that they leave behind. Most conceptual forest development models do not incorporate current knowledge of the: (1) complexity of structures (including spatial patterns) and developmental processes; (2) duration of development in long-lived forests; (3) complex spatial patterns of stands that develop in later stages of seres; and particularly (4) the role of disturbances in creating structural legacies that become key elements of the post-disturbance stands. We elaborate on existing models for stand structural development using natural stand development of the Douglas-fir—western hemlock sere in the Pacific Northwest as our primary example; most of the principles are broadly applicable while some processes (e.g. role of epicormic branches) are related to specific species. We discuss the use of principles from disturbance ecology and natural stand development to create silvicultural approaches that are more aligned with natural processes. Such approaches provide for a greater abundance of standing dead and down wood and large old trees, perhaps reducing short-term commercial productivity but ultimately enhancing wildlife habitat, biodiversity, and ecosystem function, including soil protection and nutrient retention.

Keywords: Ecosystem; Disturbance; Biological legacies; Stand-structure; Structural retention; Succession; Stand development

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Decision support for evaluating landscape departure and prioritizing forest management activities in a changing environment

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ABSTRACT

We evaluated changes (hereafter, departures) in spatial patterns of various patch types of forested landscapes in two subwatersheds ("east" and "west") in eastern Washington, USA,from the patterns of two sets of reference conditions; one representing the broad variability of pre-management era (~1900) conditions, and another representing the broad variability associated with one possible warming and drying climate-change scenario. We used a diagnostic set of class and landscape spatial pattern metrics to compare current spatial patterns of test subwatersheds against the two sets of reference conditions. In a companion decision support model built with the EMDS modeling system, we considered the degree of departure in the subwatersheds, relative to the two sets of reference conditions along with two additional criteria (vulnerability to severe wildfire and timber harvest opportunity), to determine the relative priority of landscape restoration treatments, and the potential for timber harvest to underwrite the treatments. In the decision support model, the current spatial pattern conditions of physiognomic types, cover types, forest structural classes, and those of late-successional and old forest patches of the two subwatersheds were compared against the two sets of reference conditions. The degree of departure in spatial patterns of physiognomic conditions was moderate in both subwatersheds in the pre-management era and climate-change comparisons. The situation was similar for the cover-type departure analysis, but spatial patterns of cover types increased in similarity to the reference conditions in the western subwatershed under the climate-change scenario. Spatial patterns of structural conditions showed a high degree of departure in both subwatersheds when compared to either set of reference conditions, but similarity improved in the eastern subwatershed under the climate-change scenario. Spatial patterns of late-successional + old forest structure were strongly similar to the broad envelope of conditions represented by the pre-management era reference in the western and moderately similar in the eastern subwatershed, but declined in both subwatersheds when compared with the climate-change reference conditions. When the degree of departure in spatial patterns of all patch types was considered along with vulnerability to severe wildfire and timber harvest opportunity, the eastern subwatershed rated higher priority for landscape improvement using either set of reference conditions. We conclude by considering uncertainties inherent in the analysis approach, types of sensitivity analysis needed to investigate model performance, and broad implications for forest managers.

1. Introduction

Forest landscapes throughout the interior Western United States provide both context and constraint to a host of ecological processes, plant and animal interactions; they are places where humans interact with biota and their physical environments (Hann et al., 2001). Conserving native species, key ecological patterns, processes, and human habitats alike, involves managing risk. To identify risks to native species, water and air quality, landscape structure and functionality, and other human interests and values an understanding of natural variation - and the factors controlling it - is essential. The degree of natural variation in ecological conditions is also non-stationary (Millar et al, 2007); i.e., as the

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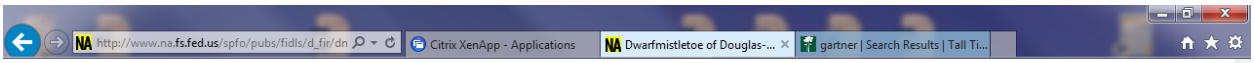

Forest Insect & Disease Leaflet 54

U.S. Department of Agriculture Forest Service

Dwarfmistletoe of Douglas-fir

By Donald P. Graham, Intermountain Forest and Range Experiment Station [1]

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Dwarfmistletoe (*Arceuthobium douglasi*i Engelm.), one of the most destructive enemies of Douglas-fir, causes serious losses in many stands. This parasitic plant is present almost everywhere within the range of Douglas-fir in the northern, central, and southern Rockies. It is abundant in eastern Washington and Oregon and is common in southwestern Oregon and northern California. It does not occur in the Douglas-fir forests west of the Cascades and north of the Siskiyou Mountains of Oregon.

Douglas-fir is the principal tree affected by this dwarfmistletoe. True firs, and possibly an occasional spruce, are sometimes attacked by it, but on these species it is of no economic importance.

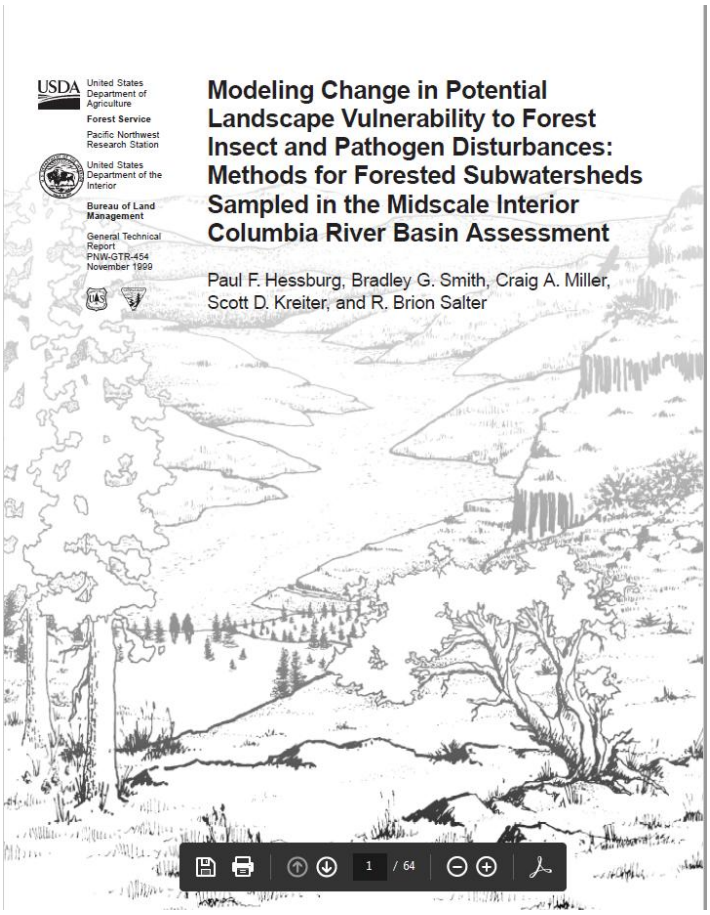
Symptoms of Infection

The most striking symptom of dwarfmistletoe infection on Douglas-fir is the formation of witches' brooms, which are more or less spherical balls of abnormal branch and twig growth (fig. 1, *A*). These brooms may be confined to a single limb or may occur on numerous limbs throughout the tree. Old mature brooms sometimes attain immense size, often including the entire crown, and generally develop long drooping or trailing branches on their lower portions. Broomed branches have lighter colored and smaller needles than normal branches do. Typical brooms generally form a few years after initial infection in trees of any age. Therefore, infection can usually be recognized even in lightly attacked trees.

Infected stands have an unsightly appearance because of trees with stunted growth, witches'-brooms, and dead tops. Often such stands also have an abnormal number of dead trees bearing the remnants of brooms (fig. 1, *C*). Some stands have only a few scattered trees infected, but stands with 50 to 100 percent of the stems attacked are much more common.

At the point of initial, infection, branches swell and become spindle-shaped. These swellings may be either pronounced or rather inconspicuous. Trunk symptoms may develop from old established infections and are characterized by large elongated and flattened cankers on one or more sides of the trunk or by spindle-shaped swellings of the trunk. More frequently the trunk has a series of small individual burls. Each burl represents the point of an old infection from which the aerial parts of the parasite have disappeared.

Dead and dying tops (fig. 1, *B*) almost always appear in heavily infected Douglas-fir stands



USDA United States Department of Agriculture
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PNW-GTR-454
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Modeling Change in Potential Landscape Vulnerability to Forest Insect and Pathogen Disturbances: Methods for Forested Subwatersheds Sampled in the Midscale Interior Columbia River Basin Assessment

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Recent changes (1930s–1990s) in spatial patterns of interior northwest forests, USA

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Abstract

We characterized recent historical and current vegetation composition and structure of a representative sample of subwatersheds on all ownerships within the interior Columbia River basin and portions of the Klamath and Great Basins. For each selected subwatershed, we constructed historical and current vegetation maps from 1932 to 1966 and 1981 to 1993 aerial photos, respectively. Using the raw vegetation attributes, we classified and attributed cover types, structural classes, and potential vegetation types to individual patches within subwatersheds. We characterized change in vegetation spatial patterns using a suite of class and landscape metrics, and a spatial pattern analysis program. We then translated change in vegetation patterns to change in patterns of vulnerability to wildfires, smoke production, and 21 major forest pathogen and insect disturbances. Results of change analyses were reported for province-scale ecological reporting units (ERUs). Here, we highlight significant findings and discuss management implications.

Twentieth century management activities significantly altered spatial patterns of physiognomies, cover types and structural conditions, and vulnerabilities to fire, insect, and pathogen disturbances. Forest land cover expanded in several ERUs, and woodland area expanded in most. Of all physiognomic conditions, shrubland area declined most due to cropland expansion, conversion to semi- and non-native herblands, and expansion of forests and woodlands. Shifts from early to late seral conifer species were evident in forests of most ERUs; patch sizes of forest cover types are now smaller, and current land cover is more fragmented. Landscape area in old multistory, old single story, and stand initiation forest structures declined with compensating increases in area and connectivity of dense, multilayered, intermediate forest structures. Patches with medium and large trees, regardless of their structural affiliation are currently less abundant on the landscape. Finally, basin forests are now dominated by shade-tolerant conifers, and exhibit elevated fuel loads and severe fire behavior attributes indicating expanded future roles of certain defoliators, bark beetles, root diseases, and stand replacement fires. Although well intentioned, 20th-century management practices did not account for landscape-scale patterns of living and dead vegetation that enable forest ecosystems to maintain their structure and organization through time, or for the disturbances that create and maintain them. Improved understanding of change in vegetation spatial patterns, causative factors, and links with disturbance processes will assist managers and policymakers in making informed decisions about how to address important ecosystem health issues. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Change detection; Landscape assessment; Spatial patterns; Reference variation; Ecosystem health; Forest health; Fire exclusion; Disturbance regimes

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Ecological subregions of the Interior Columbia Basin, USA

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Abstract. Land evaluations are not always conducted with adequate understanding of the relevant geologic and climatic contexts and their appropriate scales. This understanding is essential for developing representative sampling, monitoring, and conservation designs, and for pooling results of landscape analysis. To provide context for several regions of the interior northwestern United States, we conducted an ecoregion classification of the interior Columbia River Basin and vicinity ("the Basin"). We grouped land units that are influenced by the same higher order geology and landform features, and share similar areal composition of potential vegetation and climate attributes. We used the TWINSPAN procedure to group 7496 watersheds of the Basin into 53 ecological subregions. We evaluated the contribution of attributes to group separation by discriminant analysis, and evaluated subregion robustness to prediction by cross-validation. Classification accuracy ranged from 80 - 97% across the subregions. All watersheds were classified to a subregion, and there were strong resemblances between members of adjacent subregions. Subregions with strong resemblances shared a similar composition of attributes, but differed in relative abundance and attribute combinations. We evaluated the geologic and climatic context of each subregion considering four levels in a nested land unit hierarchy. Most subregions nested at one of at least four scales, but some overlapped. Our results suggest that observation levels for a given ecological phenomenon need not be nested within their appropriate context levels, and across broad geographic areas context of the same phenomenon occurs at different scales.

Keywords: Hierarchy theory; Interior Columbia River Basin; Land system inventory; Land unit hierarchy; Regional assessment; Regionalization; Reference condition; Representativeness assessment.

Abbreviations: ESR = Ecological subregion; PVT = Potential vegetation type.

Introduction

The U.S. Department of Agriculture, Forest Service is responsible for managing the lands and resources of the National Forest System which includes 78 million ha distributed over 155 national forests, 20 national grasslands, and various other lands. Regional assessments of public lands in the western United States have documented declining biological diversity, productivity, and sustainability of terrestrial and aquatic ecosystems in the 20th century (Covington et al. 1994; Anon. 1993, 1996; Quigley & Arbelbide 1997; Haun et al. 1997, 1998; Hessburg et al. 1999a). Public land managers now face increasing social pressure to transform existing forests and rangelands to reflect conditions resulting from natural climate and disturbance regimes and patterns of biophysical environments.

In December of 1997, the U.S. Secretary of Agriculture convened a distinguished committee of scientists to review Forest Service planning and offer recommendations. As a result, the Department recommended rule changes to the National Forest Management Act of 1976 (Anon. 1999). Several broad goals shape the proposed rule which represents a landmark paradigm shift for public land management in the U.S. Chief among these is the need to promote social and economic sustainability in the context of sustainable ecosystems. Ecological and socio-economic contexts will be established with regional assessments, and a variety of regionalizations will be needed, e.g., a hydrologic regionalization will be developed that groups watersheds of a region in a manner that minimizes variation in hydrologic processes.

Regionalization in landscape evaluation

Macroclimate accounts for the largest share of environmental variation at a regional scale; weather patterns, atmospheric flows, temperature, precipitation, and solar radiation constrain the biota to that which conforms to the environmental variation of a region (Neilson 1986, 1987). Likewise, climate constrains broad patterns of disturbance and other processes that operate within the context of that environmental variability. Climatic regionalizations are based on generalized air mass boundaries (Mitchell 1976), and vegetation patchiness is correlated with the distribution of major biomes (Neilson 1986). Regional climate zones are defined by their unique climatic regime, zonal soil types, and climatic climax vegetation (Troll 1964;

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REVIEW ARTICLE

Restoring fire-prone Inland Pacific landscapes: seven core principles

Paul F. Hessburg · Derek J. Churchill · Andrew J. Larson · Ryan D. Haugo · Carol Miller · Thomas A. Spies · Malcolm P. North · Nicholas A. Povak · R. Travis Belote · Peter H. Singleton · William L. Gaines · Robert E. Keane · Gregory H. Aplet · Scott L. Stephens · Penelope Morgan · Peter A. Bisson · Bruce E. Rieman · R. Brion Salter · Gordon H. Reeves

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Abstract
Context More than a century of forest and fire management of Inland Pacific landscapes has transformed their successional and disturbance dynamics. Regional connectivity of many terrestrial and aquatic habitats is fragmented, flows of some ecological and physical processes have been altered in space and time, and the frequency, size and intensity of many disturbances that configure these habitats have been altered. Current efforts to address these impacts yield a small footprint in comparison to wildfires and insect outbreaks. Moreover, many current projects emphasize thinning and fuels reduction within individual forest stands, while overlooking large-scale habitat connectivity and disturbance flow issues.
Methods We provide a framework for landscape restoration, offering seven principles. We discuss their implication for management, and illustrate their application with examples.
Results Historical forests were spatially heterogeneous at multiple scales. Heterogeneity was the result of variability and interactions among native ecological

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Technical Commentary

A Structural Classification for Inland Northwest Forest Vegetation

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Existing approaches to vegetation classification range from those based on potential vegetation to others based on existing vegetation composition, or existing structural or physiognomic characteristics. Examples of these classifications are numerous, and in some cases, date back hundreds of years (Mueller-Dombois and Ellenberg 1974). Small-scale or stand-level multiple resource management has used potential vegetation/site classifications for several decades (Daubenmire and Daubenmire 1968, Layser 1974, Pfister and Arno 1980, Ferguson et al.1989). At broader scales, ecosystem management efforts are aided by classifications of forest vegetation that provide simple representations of vegetation composition and structural attributes that change over time and space (Oliver 1992, Swanson and Franklin 1992, McComb et al. 1993, Oliver et al. 1994, Turner et al. 1995). However, over broad areas in the Inland Northwest, rugged mountainous topography, contrasting geologic substrates, and a highly variable maritime influence from the Pacific coast combine to create wide variety in vegetation types and productivities.

Ecosystem managers in the Inland Northwest need a classification system based on biologically significant vegetative characteristics that capture this variation, and one that is comprised of variables that describe structural conditions important to achieving management objectives. Existing potential vegetation classification systems provide useful representations of the effects of soils and climate on vegetation composition, but do not reflect differences in disturbance history. In most western forests, disturbances are a primary factor affecting the composition and structure of vegetation (Oliver 1981, Habeck 1987, Agee 1993). In addition, potential vegetation classes cannot be directly identified through remote sensing and therefore require modeling and expensive ground surveys for validation.

In this paper, we examine some alternative vegetation classification systems following the framework presented by Kimmins (1987) for vegetation classification except that we only discuss categories that include systems commonly used in the Inland Northwest. We advocate the use of a structural or physiognomic vegetation classification based on the biological process of stand development which can be used across variable spatial scales.

Structure is an ecologically significant attribute of vegetation considered to have three major components (Kershaw 1964): (a) vertical structure; (b) horizontal structure; and (c) quantitative structure. Quantitative structure may be further specified according to life forms, floristics, or size-class distributions (Mueller-Dombois and Ellenberg 1974). The distribution of life forms has been suggested as a fundamental axis contributing to the coexistence of species and the organization of ecosystems (Cody 1986). Mueller-Dombois and Ellenberg (1974) state that structural similarities between communities provide a basis for the comparison of functions.

We believe a structural vegetation classification based on stand development processes reflects fine- and coarse-grained processes which operate across stands and landscapes. At small scales such as at the stand or patch level, a structural classification would be useful for creation of vegetation structures which meet specific resource management objectives. At larger spatial scales, a structural classification can serve as the basis for predicting and planning for vegetation change over time. Further, a simple classification with a small number of classes can reduce the complexity of landscape-scale modeling and planning. For example, a hypothetical area with 10 forest vegetation types and 10 vegetation development classes has 100 possible vegetation units. Compounded by variations in rate of growth or progression through these 10 classes caused by site, disturbance, management treatment, and spatial characteristics of vegetation units, a sizable planning problem is created. Finally, at global scales, remotely sensed vegetation classifications will likely be limited to physiognomic structural parameters (Running

Note: The development of the structural stage classification presented in this paper was supported by the Columbia River Basin Ecosystem Assessment Project and the USDA Forest Service Northern Region. Helpful reviews of this manuscript were provided by Paul Alaback, Stephen Arno, Regan Calloway, Richard Hutto, and Ray Shearer.

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Decision support for integrated landscape evaluation and restoration planning

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Abstract

The historical patterns of Inland Northwest United States forests have been dramatically altered by a little more than two centuries of human settlement and land use. Spatial patterns of forest structural conditions, tree species composition, snags and down wood, and temporal variation in these patterns, have been altered to such an extent that the natural ebb and flow of terrestrial habitats and their linkages has been disrupted. Closely coupled with these changes, fire and other disturbance processes in most dry and many mesic forest types have also shifted, with a bias for increased severity and extent. Here, in the context of planning restoration of some semblance of historical vegetation pattern-disturbance process interactions, we briefly revisit why it is theoretically sound to estimate the range and variation in historical forest spatial patterns. We call these estimates of range and variation, reference conditions or reference variation (RV), and discuss how forest managers might use them when evaluating current landscape patterns to identify changes that may have important ecological implications. We term such evaluations, departure analyses, and we describe how departure analysis is implemented in a decision support system (DSS) for integrated landscape evaluation and restoration planning. The initial phase of the DSS uses logic-based modeling to evaluate existing patterns of forest vegetation in subwatersheds of one ecoregion against a corresponding envelope of historical reference conditions for the same region, thereby highlighting key departures. The secondary planning phase uses results from the analysis phase in a decision model to prioritize watersheds for possible management actions related to landscape restoration and maintenance. We conclude from our example that there are at least two advantages to a decision-support approach that treats evaluation and planning as distinct but integrated phases: (1) the overall decision process is rendered conceptually simpler and (2) practical considerations of efficacy and feasibility of management actions can be easily accommodated.

Keywords: Criterion DecisionPlus; Decision support; EMDS; Historical range of variation; Landscape evaluation; Monitoring; NetWeaver; Restoration; Scenario planning

1. Introduction

Human settlement and forest management activities have drastically changed the patterns and processes of forest landscapes across the Inland

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United States Department of Agriculture

Forest Service

March 2012

Methow Valley Ranger District Western Spruce Budworm Landscape Assessment

Okanogan-Wenatchee National Forest

Appendix A: Summary of GIS Analysis Methods

Proposed commercial thin and noncommercial thin vegetation and fuels treatment units:

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Buttermilk Creek landscape pre-treatment vegetation attributes:

T:\FS\NFS\OkanoganWenatchee\Project\MET\MissionForestAndFuels2012\GIS\Data\NCFHC_Churchill\GIS_final\Shapefiles\
Butter_Attributes.shp

Libby Creek landscape pre-treatment vegetation attributes:

T:\FS\NFS\OkanoganWenatchee\Project\MET\MissionForestAndFuels2012\GIS\Data\NCFHC_Churchill\GIS_final\Shapefiles\
Libby_Attributes.shp

Buttermilk Creek landscape post treatment vegetation attributes:

T:\FS\NFS\OkanoganWenatchee\Project\MET\MissionForestAndFuels2012\GIS\Workspace\mtrebon\EMDS_Analysis\
Butter_Attributes_PostTx_20160921.shp

Libby Creek landscape post treatment vegetation attributes:

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Libby_Attributes_PostTx_20160921.shp

Presence of medium and large trees in Buttermilk Creek landscape:

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Butter_SIZE_MEDLG_2_3_420160927.shp

Presence of medium and large trees in Libby Creek landscape:

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Libby_SIZE_MEDLG_2_3_20160927.shp

Buttermilk Creek landscape Douglas-fir bark beetle vulnerability:

T:\FS\NFS\OkanoganWenatchee\Project\MET\MissionForestAndFuels2012\GIS\Workspace\jdaily\shapefiles\
Butter_DFB_Haz_20161220.shp

Libby Creek landscape Douglas-fir bark beetle vulnerability:

T:\FS\NFS\OkanoganWenatchee\Project\MET\MissionForestAndFuels2012\GIS\Workspace\jdaily\shapefiles\
Libby_DFB_Haz_20161220.shp

Buttermilk Creek landscape dwarf mistletoe vulnerability:
T:\FS\NFS\OkanoganWenatchee\Project\MET\MissionForestAndFuels2012\GIS\Workspace\jdaily\shapefiles\
Buttermilk_DwarfMistletoe_Vulnerabiliy20161118.shp

Libby Creek landscape dwarf mistletoe vulnerability:
T:\FS\NFS\OkanoganWenatchee\Project\MET\MissionForestAndFuels2012\GIS\Workspace\jdaily\shapefiles\
Libby_DwarfMistletoe_Vulnerability20161119.shp

Appendix B: Literature

Please include a photocopy or scan of the title page or book cover for each reference that you cited – excluding forest plans and other overarching guidance. This is an important part of the project record. If we are appealed this assists the team assembling the project files and saves you having to clean your desk to find it!